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Modifying SIL-Certified Equipment Failure Rates on the Basis of Deployment
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Chemicals & Allied Products	12,419	Rubber & Miscellaneous Plastic Products	3,499
Food & Kindred Products	11,355	Paper & Allied Products	3,311
System Integrators & Engineering Design Firms	9,261	Stone, Clay, Glass & Concrete Products	1,855
Primary Metal Industries	5,232	Textile Mill Products	1,219
Electric, Gas & Sanitary Services	4,174	Tobacco Products	137
Petroleum Refining & Related Industries	3,789	Total Circulation	60,020
Pharmaceuticals	3,769		

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Connecting the Manufacturing Dots

WALT BOYES
EDITOR IN CHIEF
wboyes@putman.net

Since 2010, I've been part of an organization called the Smart Manufacturing Leadership Coalition (https://smartmanufacturingcoalition.org). SMLC is working to define an overarching operating system for manufacturing. Why do we need to do that? Can't we just use what we've got? ● It isn't that simple. ● Among the biggest issues

manufacturing companies say they are facing are integration of data across their supply chains and workforce development to replace retiring workers.

Data integration is extremely hard to do. For example, one of the attendees at the October SMLC meeting noted that she needs to get particle size distribution and elemental concentration and moisture for her input feedstock, and what she gets is a paper (or electronic copy of a paper) certification. It isn't the same thing, so the company has to have wide acceptance brackets for its feedstocks, which leads directly to non-optimal performance. It's sometimes possible to build brittle application program interfaces (APIs), but as another participant said, "They last as long as the people who wrote them are employed there." It's critical to improve this kind of data transfer because, if it isn't competitive to make the products here in the United States, they will be made elsewhere.

Workforce development is another sore point. It's clear that there's a workforce shortage, especially in the technically literate job area. If we want to keep manufacturing here, we need to have people who want those jobs and who qualify to work in them.

Large companies can afford workforce development and training. They can support integrated supply chains (to the extent their suppliers will let them). But small- and medium-sized companies just can't afford to implement the systems and support structures necessary to use smart manufacturing technologies.

And these technologies already, for the most part, exist. Mark-up languages, data conduits like OPC and fieldbus, databases, low-cost sensors, standards such as ISA88, 95, 99 and 06, and IEC standards such as 61499 all exist. They are all tools, but not every plant that could use them does.

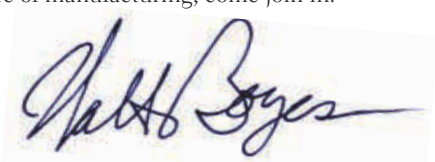
Can you integrate all your systems? Sure. Just buy everything from a single vendor. But what if you don't want to do that? Worse yet, what if you have to start telling your suppliers that they also have to use the same vendor you do. What do you think their answer will be? Likely it will be, "Not only no, but absolutely not!"

So what to do? Think of how a computer operating system works. One of the reasons that modern enterprises work is the predominance of Windows (and to a lesser extent Linux and Apple) as an operating system. Wouldn't it be easier to interconnect supply chains in an open manner using best-of-breed products if there were an overarching operating system for manufacturing? Of course, it would. But how do you get that system?

SMLC is not looking to replace current control systems or even current ERP systems. Rather, the system to be developed is going to be designed to make interconnection and interoperation easier, or even possible.

Even though SMLC is really still in its infancy, some really interesting ideas have already come forward. What would happen if you used, instead of cycle time or response rate, the concept of workflow? Suppose you could spread the cost of this workflow-based programming across a number of companies by using Software as a Service (SaaS) and cloud computing? Now small companies could afford to use the tools, too. We'll be talking about this revolutionary concept more in the future.

SMLC will help define smart manufacturing for the future. If you're interested in the future of manufacturing, come join in.



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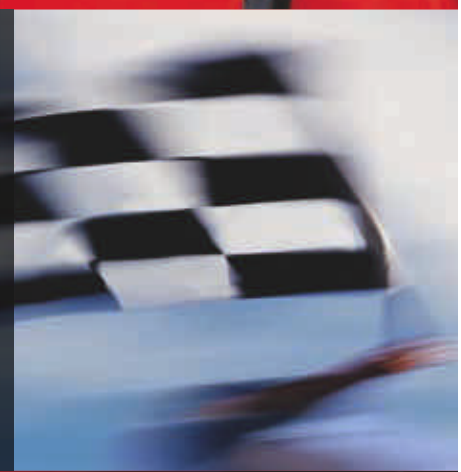

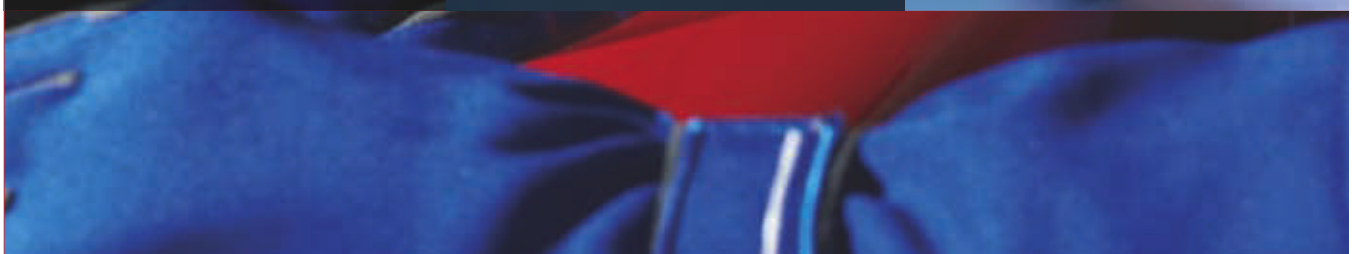

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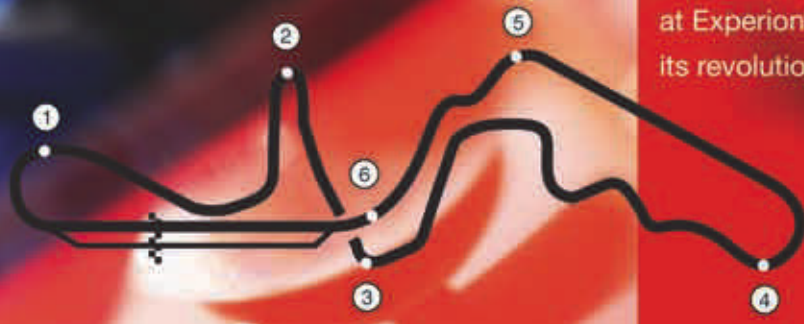

What's Your Roadmap?

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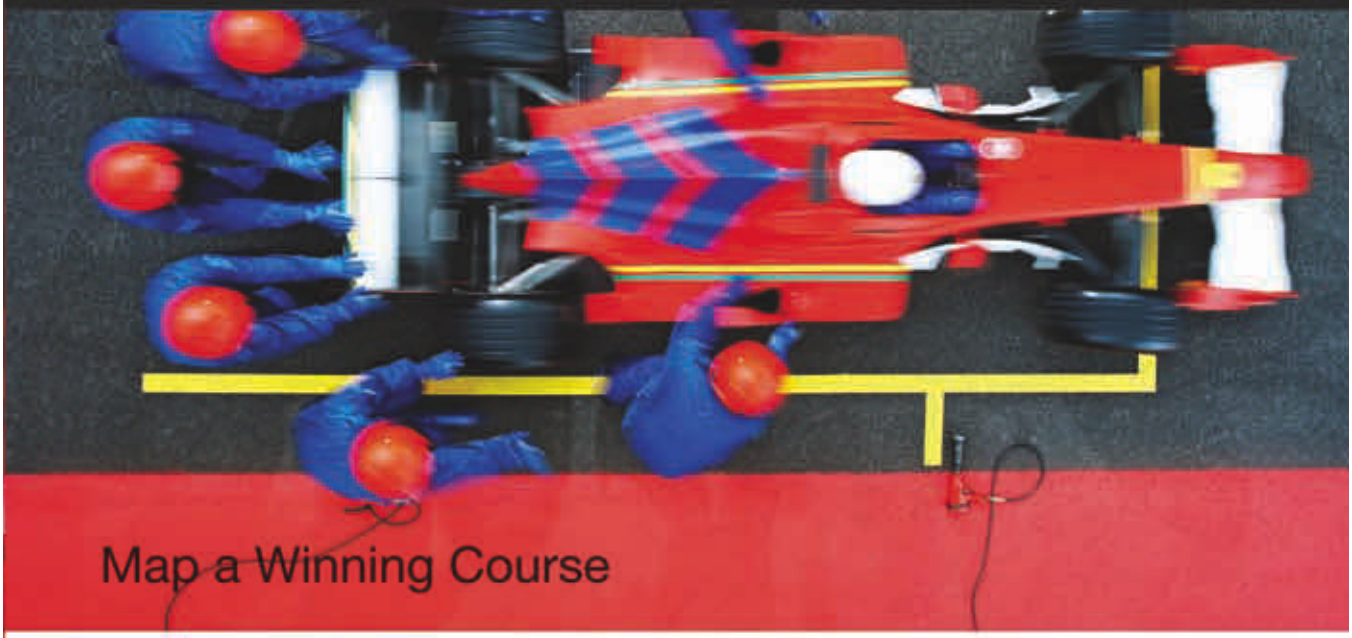

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Why You Come to ControlGlobal.com

WALT BOYES
EDITOR IN CHIEF
wboyes@putman.net

"I know it's true! I read it on the Internet!" Well, no. There is a lot of information on the Internet that is just plain wrong. Unfortunately, some of the information that is very available on the Internet is also very plausible. However, in an engineering discipline, if you aren't careful, you can get seriously burned.

That's where we come in. Both in *Control* magazine and on www.controlglobal.com, we are editors. That's much more than being spell checkers and grammar queens. We are fact checkers; we are purveyors of knowledge; and we are, fundamentally, the curators of the process automation space.

What's a curator? We think about curators with respect to museum exhibits, not magazines or websites. A curator is a person who is a content expert responsible for acquisition and interpretation of collections of information and material. Here we function quite a bit like a museum curator, but for the process automation space.

We collect information—articles, white papers, product and news announcements, blogs, tweets, special projects, videos, podcasts, ebooks and more—and we present them to you in an easily available format, sorted, edited, curated for your use. Sometimes we find this information, and sometimes we commission new works.

We can do this because we have put together a group of subject matter experts to work on our collections, people like Greg McMillan, Stan Weiner, Béla Lipták, Joe Weiss, John Rezabek, Dan Hebert, Jim Montague, Nancy Bartels, Katherine Bonfante, a host of other end users and knowledgeable vendors, and finally, your humble servant.

The difference between what you can find on Google (about 45 million results for "process automation") and what you can find on ControlGlobal.com and in *Control* magazine is the value we bring to you—actionable information that you can use and that you can trust.

We aren't just passive accumulators of information. We go out and find what you need to know. We broke the Stuxnet story back in 2010 and have followed it all the way. We have curated a large body of material on cybersecurity. We followed the wireless standards imbroglio to try to keep you from being confused and we did it from the inside, by actively participating in the standards process.

We provide deep content on field devices, networks, wireless, final control elements, controllers and control systems, and we do it in a way you can trust.

"I know it's true! I saw it on ControlGlobal.com"

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Tips for Compressor Surge Control
A checklist of ways to control difficult compressor surges. http://community.controlglobal.com/content/checklist-compressor-surge-control-tips

To Disclose or Not
Unfettered's Joe Weiss discusses security in the nuclear industry. http://community.controlglobal.com/content/nuclear-plant-cybersecurity-and-information-disclosure-or-lack-thereof

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Blog Posts You Might Have Missed

Among the real stars of ControlGlobal.com are some of our most popular bloggers, Greg McMillan and Joe Weiss. Greg not only is half of the ControlTalk team and occasional feature writer, but the brains behind the Control Talk blog (not to be confused with the monthly column of the same name), which covers modeling and control.

In the last few weeks, Greg has been providing his readers with checklists for control issues. In his "Checklist for Cascade Control," Greg calls cascade control "an effective way of providing better feedback and feed-forward control. The peak error in the primary loop can be reduced by more than an order of magnitude for disturbances originating in the secondary loop. The nonlinearity of a control valve can be removed from the primary control loop. Flow feed-forward and ratio control can become more effective. To read the entire post, go to http://community.controlglobal.com/content/checklist-cascade-control.

The other hit is "Checklist for Batch Reactor Temperature Control." Greg says, "Tight reactor temperature control enables the optimization of capacity and yield. What happens upfront in the reaction sets the stage for downstream processing and what ultimately ends up in the final product. Generally, increasing reactor temperature will increase reaction rate (capacity), but if the temperature is too high, side reactions may develop reducing reaction selectivity (yield). Oscillations and errors will prevent operating closer to the optimum temperature. This checklist offers questions to improve reactions by addressing the heating and cooling system design, thermal lags, split ranged discontinuities, tuning, reactant feed and the need for a measurement of fouling and conversion." To read the entire checklist go to http://community.controlglobal.com/content/checklist-batch-reactor-temperature-control.

Our resident expert on cybersecurity is Joe Weiss. He is a principal at Applied Control Solutions and an authority on cybersecurity and control systems. In his "Unfettered" blog, he crusades for better, more effective security of critical infrastructure and process control systems.

Joe's most popular post of recent weeks has been "Lessons Learned from Aurora." He begins, "On the SCADASEC list, Ed Beroset stated the following: 'I've attended a number of security conferences at which speakers would gravely intone that 'we have not yet learned the lessons of Aurora.

'I've found that there's a very wide range of interpretations as to what those might be. My questions for this group are: 1) what is the lesson of Aurora? and 2) what has been done about it? and 3) what's left to do?' In response to Ed, there are a number of lessons learned specifically from Aurora." To read the entire post, go to http://community.controlglobal.com/content/lessons-learned-aurora.

In his post, "Legacy Control System Cybersecurity/Reliability Test Bed," Joe reports, "There has long been a strong desire to find solutions for securing industrial control systems that go beyond simply exposing problems and risks. What is so difficult about finding solutions? The answer is technology, use and compliance. Solutions exist for some parts of the control system that have been adopted/adapted from the IT community." To read the complete post by Joe, go to http://community.controlglobal.com/content/legacy-control-system-cybersecurityreliability-test-bed. ■

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Why Nuclear Needs Process Automation

I spent the last year reviewing the Three Mile Island, Chernobyl and Fukushima accidents, and found that neither they, nor practically any of the 435 operating nuclear plants around the world, were designed to provide safe shutdown in case of simultaneous external and internal electricity failure. Similarly, few of them are protected against hydrogen explosions, and practically none can handle regular or cyber terrorist attacks.

Most are operated in a semi-manual mode. Many were designed for a useful life of 30 years, but have already reached 40 and are still getting extensions. In addition, neither permanent waste disposal, nor the decommissioning of the plants, is resolved. For example, Chernobyl occurred in 1986, yet the completion of its decommissioning is planned for 2015. Under these conditions, the question is not if, but when and where, the next accident will occur.

In the forthcoming new edition of my handbook, I devote a full chapter to improving the safety of nuclear plants through automation, and I show that the causes of the three best-known nuclear accidents were very similar, and that the use of state-of-the-art automation could have prevented all three of them. In this series of articles, I will give a brief summary of that chapter.

History

During the last 60 years, nuclear energy has become an important component in the energy mix of mankind. It supplies about 5% of the total global energy consumption, or about 13.5% of global electricity consumption. In the United States, nuclear energy is the source of about 8% of the total energy consumption, or about 20% of the total electricity used.

Figure 1 shows that after the accidents at Three Mile Island and Chernobyl, the building of new nuclear power plants slowed, and the percentage of global electricity consumption met by

The key to the safety of nuclear power plants is to maintain the availability of coolants, even if all electric power supplies fail.

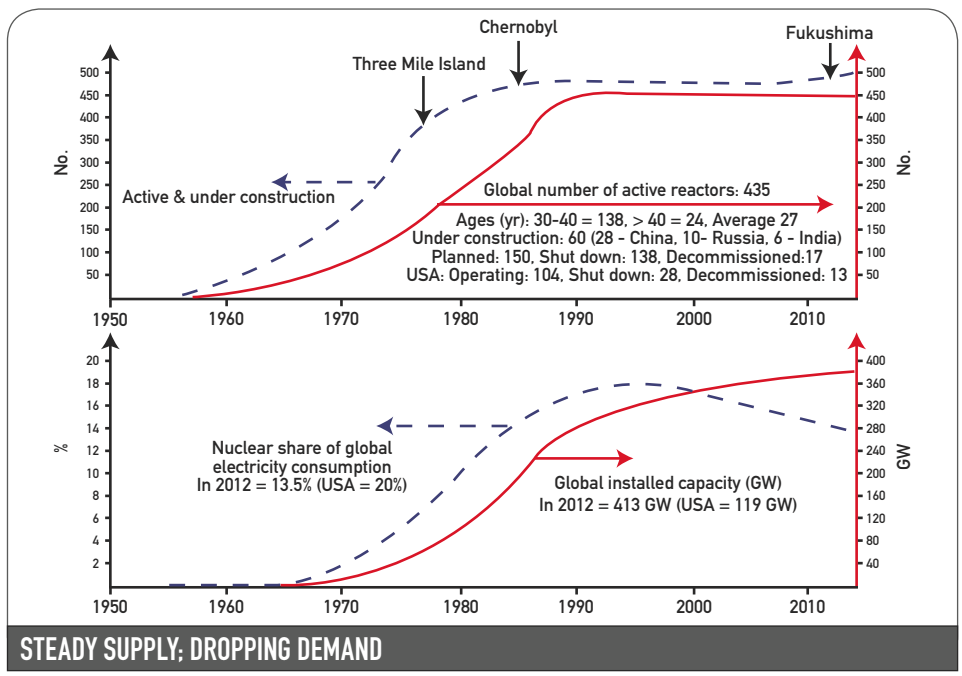

Figure 1. Red line in top chart shows number of active reactors; the blue dotted line includes planned reactors. Red line in bottom chart shows current capacity; blue dotted line, share of consumption.

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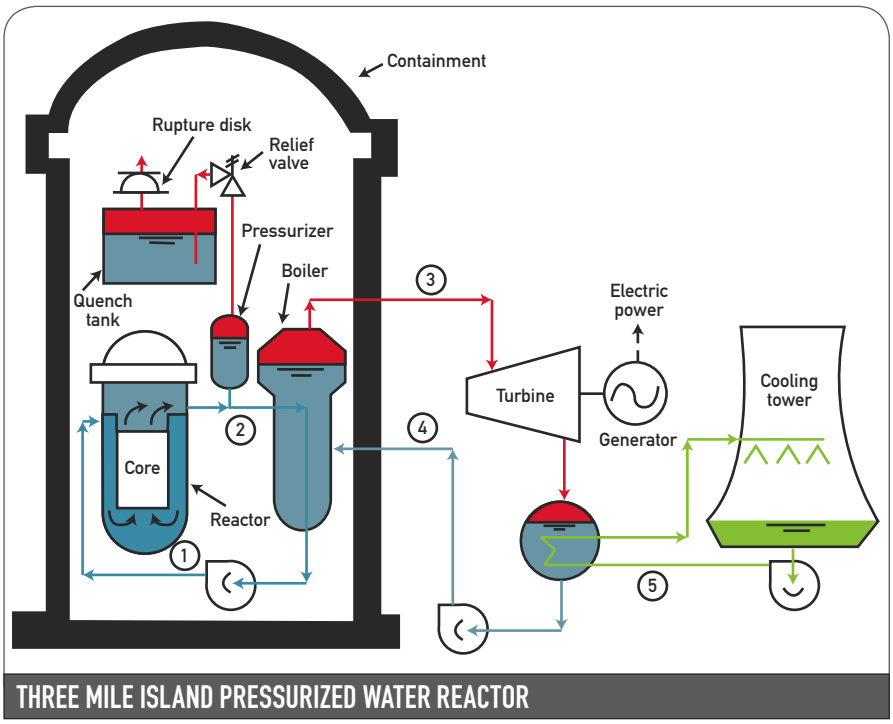

THREE MILE ISLAND PRESSURIZED WATER REACTOR

Figure 2. The primary pump (1) circulated the primary water, while the secondary water was circulated (4) by the secondary water pump until its suction valve was accidentally closed.

nuclear power dropped from 18% in the early 1990s to 13.5% by 2012. Some nations have decided to end the use of nuclear energy (Germany by 2020, Japan by 2040), yet as of today, 60 new plants are under construction and another 150 are contemplated because some argue that the consequences of their use is less dangerous than the continued burning of fossil fuels.

The Process

In fossil-fuel-burning power plants, the fuel is continuously charged from outside the boiler, while in nuclear power plants, the heat is obtained from fuel stored inside the boiler. Therefore, the fuel flow to fossil boilers is easy to shut off, while in the nuclear process, the fuel "leaks." Decay heat continues to be released after shutdown, and, therefore, the cooling of the fuel rods must continue. The key to the safety of nuclear

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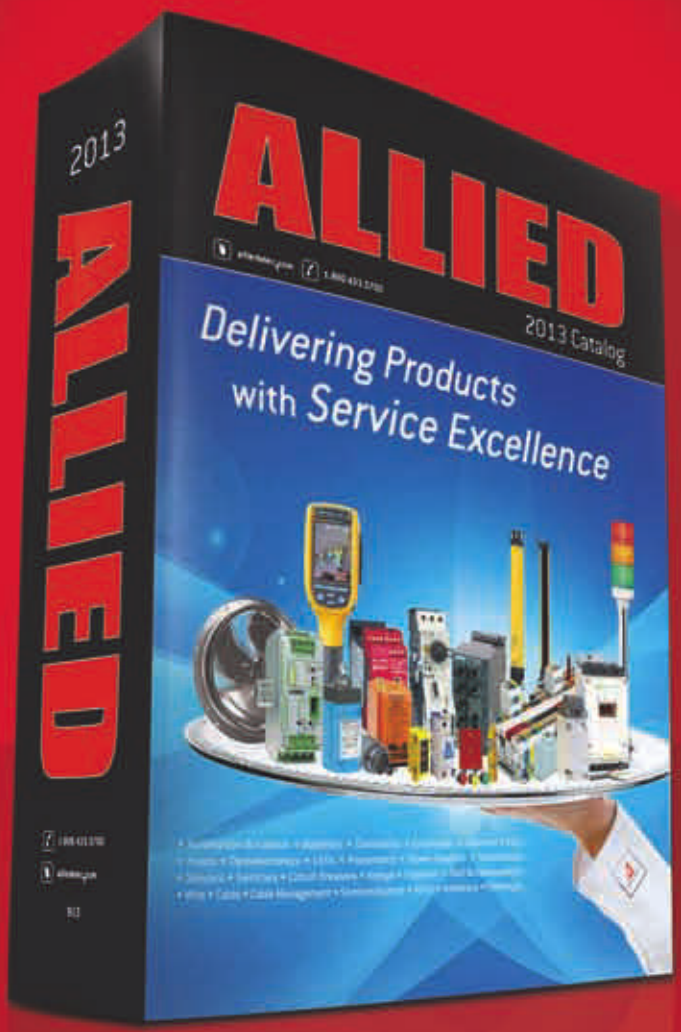

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power plants is to maintain the availability of coolants, even if all electric power supplies (external and internal) simultaneously fail for extended periods.

The second key to safety is to make sure that, if cooling fails and the fuel rods melt, causing the molten zirconium in their cladding to react with the water and generate hydrogen, the generated hydrogen does not explode. This requires that it be safely released outside the containments of the reactor building. In order for hydrogen to explode, it needs oxygen and an ignition source. Therefore, these must be denied by the design, while the hydrogen is being routed to the outside.

Three Mile Island

At 4 a.m. on March 28, 1979, Unit 2 of the 900-MW reactor at Three Mile Island (TMI-2) in Pennsylvania experienced a partial core meltdown. Between 13 and 43 million curies of radioactive krypton gas were released, half the core melted, and 90% of the fuel-rod cladding was destroyed. The maximum offsite radiation reached 83 millirems, but the radiation dose received by the community was small.

The plant was designed by GE for a life of 30 years, began operation in 1978, and it is still in operation today. In fact, in 2009 it received approval to continue operation for another 20 years. Figure 2 (p. 18) shows approximately the main equipment and piping of the plant. At the time of the accident, the controls of the plant were mostly manual and mostly pneumatic. So what happened?

Operators working on a demineralizer at 4 a.m. accidentally admitted water into the instrument air supply to part of the control system. This caused the valve on the suction side of the secondary cooling water pump to fail closed, in spite of the fact that best practice for cooling service is to have valves fail open.

The operators did not realize what they had done because the control system did not include the required automatic safety alarms, nor was there an automatic interlock to shut down the reactor or to start up a backup cooling system when the secondary cooling water flow stopped.

The designers of the plant were also responsible because, for cooling service, they should have specified closed-failure positions, and should have provided automatic scram (shutdown) of the reactor and automatic starting of emergency cooling upon failure of the flow of cooling water.

In the next segments in this series of articles I will describe the events at Chernobyl and Fukushima and will show how those plants should have been automated to protect against the accidents that occurred. ■

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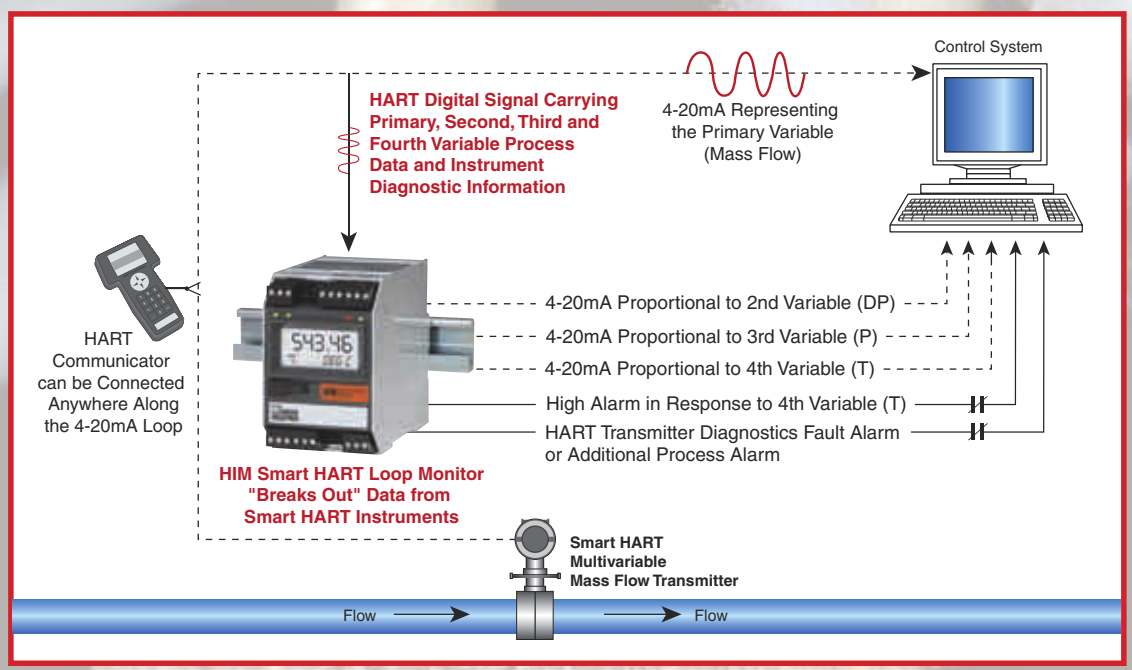
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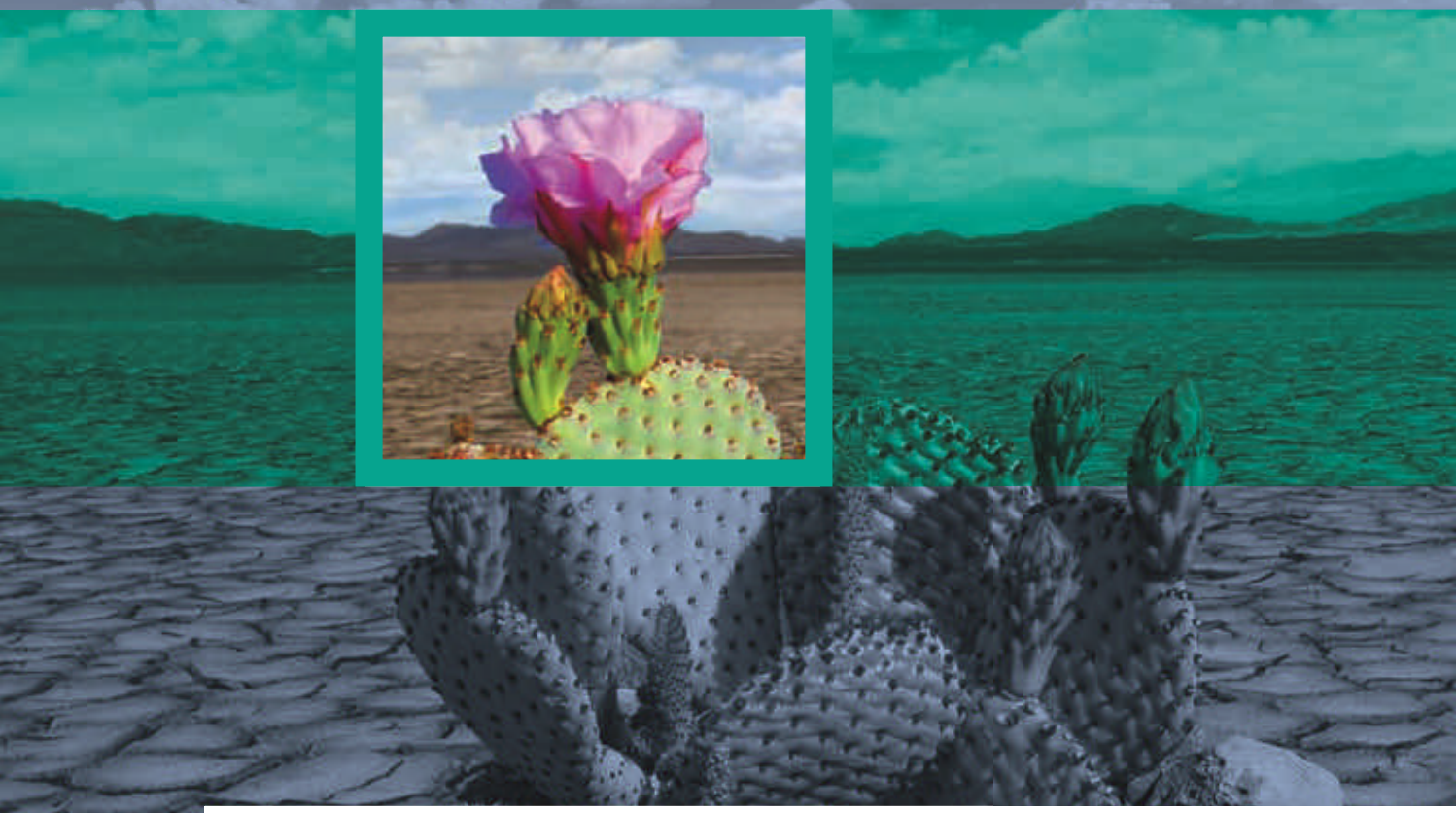

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When to Use Control in the Field

JOHN REZABEK
CONTRIBUTING EDITOR
JRezabek@ashland.com

Back in the 1990s, when ISA's SP50 committee was meeting to debate the specifications and features that would become part of the evolving fieldbus digital communication standard, the idea of field devices solving function blocks was adopted. Devices would not just measure something and make a process variable available to a host, or translate an analog output to a valve stem position, they would have the (largely optional) capability to support and solve a whole repertoire of standard function blocks.

A function block is an object, a small "app," that performs a very specific duty, with a specified set of inputs, outputs and internal configuration parameters. An analog input block, or "AI," performs the basic I/O chores of translating a raw measurement, say a differential pressure, into a meaningful process variable in engineering units. It has a menu of linearization choices that includes square root extraction and some innate alarming capabilities.

Most of this was nothing new. What was new was that devices became "autonomous"—capable of accepting inputs, solving their blockware and publishing an output—without being poked or polled by a centralized host. They can communicate with other devices and with the host as peers, and are even capable of solving PID for closed-loop control.

The end users who desired this capability were people with process control or a DCS focus, and they saw a move to an entirely vendor-independent, digital, distributed and deterministic control platform as a logical evolution of the systems of that day.

Today, there are still a lot of folks who use fieldbus for I/O only. But, many of the process control specialists who experimented with fieldbus-solved PID have caught on to the vision of the architects of SP50—that fieldbus would become a more robust, truly distributed and innately more reliable platform for rudimentary PID loops. In growing numbers, users are deploying fieldbus, employing this long-dormant capability to not only have fully digital I/O, but also a fully digital and distributed control system, vendor-neutral and independent of the host. Many systems people may never land a wire or lay their hands on a positioner or buy a transmitter, but they realize that the reliability of their control schemes hinges on these devices, no matter where PID is solved. And, if one can also solve PID with improved determinism, speed and integrity, there's nothing to lose and much to gain by exploiting it.

But there will always remain many loops for which control in the field (CIF) isn't an option. Fitting compressor speed controls or complex schemes requiring nonlinear controls, adaptive gain scheduling or complex cascades into the relatively generic repertoire of fieldbus function blocks might be a struggle.

If you're leading a project, you'd like a simple and straightforward bit of guidance to help your consultant/EPC easily choose the logical applications for CIF or control in the host, such as:

- Whenever the output of a PID block is configured to be wired directly to the AO block of a valve, CIF shall be the default choice for solving PID. The PID should be executed in the positioner, allowing the operator to run the block and, hence, the valve in "manual," even when all the other devices in the loop are being serviced.
- HMI faceplates shall use the output of the loop's AI block to display the measured variable, so it remains a live value even when the positioner is being replaced. The device measuring the variable controlled by the PID shall always be on the same segment.
- The remaining loops—cascade masters, for example—may be configured to run in the host with little loss of performance. Any output being controlled by 4-20 mA—for example, most variable-frequency drives—also are sensible choices for being solved in the host.

Exploiting control in the field is never an all-or-nothing proposition. A couple simple guidelines can be employed to help ensure your projects have a logical basis for their application. ■

Fieldbus would become a more robust, truly distributed and innately more reliable platform for rudimentary PID loops.

Invensys Buys Spiral Software

U.K. petroleum software specialist increases IOM's footprint in refining sector.

Invensys Operations Management (IOM, http://iom.invensys.com) has acquired Spiral Software (www.spiralsoft.com), a privately held company headquartered in Cambridge, U.K. Founded in 1998, Spiral Software provides integrated solutions ranging from crude assay management to refinery supply chain optimization, enabling clients to make the best possible choices in trading and refining crude oil. Spiral's crude oil knowledge management tools help companies track the quality of feedstocks and predict their refining behavior. Fully integrated refinery planning and scheduling help optimize production plans based on real-time crude demand and market pricing, as well as the refinery's own capacity and supply chain constraints.

"This acquisition complements our existing refinery-wide optimization strategy and leverages our SimSci-Esscor modeling and optimization offerings for the hydrocarbon processing industry," said Ravi Gopinath, president of IOM's software business. "Spiral Software provides the only integrated refining-industry solution designed from the ground up, bringing together feedstock data management, planning and scheduling. This means that our SimSci-Esscor offerings will now fully support and optimize the entire refining value chain, from crude trading to supply-chain distribution, including lifecycle modeling from design to start-up to performance optimization."

"Combined with Invensys Operations Management's existing refinery optimization offerings, our capabilities in feedstock data management and refinery supply chain optimization will allow us to provide a unique, end-to-end solution across the full oil sector value chain," said Matthew Webster, chief executive officer, Spiral Software.

Ravi Gopinath, president of IOM's software business; right: Matthew Webster, CEO of Spiral Systems.

The business will continue to be managed by Spiral Software's existing executive team, adding employees to Invensys operations in the United Kingdom and North America. No financial terms for the deal were announced.

Automation Market Downshifts in 2Q 2012

According to Allen Avery of ARC Advisory Group, after several quarters of strong growth following the global recession, automation market expansion has slowed decidedly. Whereas previous quarters saw double- and high single-digit growth rates, the second quarter of 2012 saw a paltry 2.7% growth in supplier revenues.

While they continue to execute many projects around the globe, suppliers cited several reasons for the more modest growth. These include both economic uncertainty in the United States and Europe and a cooling down of the once white-hot Chinese economy. New order activity also fell off somewhat for some suppliers as the rebound effects from the global recession have waned, and they convert their order books into revenues. However, suppliers still reported robust activity in the key power, oil and gas, and mining sectors. The order backlogs that suppliers have accumulated are still healthy, indicating that growth should continue for the foreseeable future.

Shale Gas Supports Rosy Outlook for U.S. Chemicals Industry

The expansion of the shale gas market could potentially drive significant benefits to the U.S. chemicals industry, including decreased raw material and energy costs, according to a new report by PwC U.S. titled, "Shale Gas: Reshaping the U.S. Chemicals Industry." In fact, another recent PwC report estimated that the potential impact of shale gas on U.S. manufacturing could enable U.S. manufacturers to lower their raw materials and energy costs as much as $11.6 billion annually by 2025.

Before natural gas from shale can be transported efficiently and sold commercially, impurities must be extracted. The byproducts of this process, known as natural gas liquids (NGL), include hydrocarbons such as ethane, butane and propane. The chemical industry uses NGL's to produce a variety of derivative products that ultimately become raw materials for multiple manufacturing sectors. In the case of ethane, they convert it to ethylene—the most significant single chemical in terms of volume and value—and then a range of downstream products. A sampling of manufacturing sectors that ultimately benefit from greater capacity and more attractive pricing of NGLs

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"As the U.S. chemical industry expands NGL conversion into a higher volume of downstream products, the positive impacts could flow through the value chain into other manufacturing sectors, particularly given that chemicals are used in an estimated 90% of all manufactured products," said Anthony Scamuffa, U.S. Chemicals leader for PwC. "Not only could the abundance of NGLs help drive reduced pricing for derivative products, it could also potentially drive domestic re-shoring activity and possibly bring about a favorable shift in the U.S. balance of trade as ethylene capacity comes on line."

Major oil and gas companies and upstream commodity industry participants are evaluating their business models and actively moving forward to take advantage of emerging shale gas opportunities. Some are considering whether to restart mothballed assets, invest in greenfield projects, form strategic alliances, and expand and upgrade existing assets. Many of these companies are also executing large capital projects, identifying engineering and construction resources, and establishing strategic sourcing agreements with NGL providers.

Further downstream, specialty chemical entities are starting to feel the effects of natural gas and NGL prices on their business models. Moreover, as the commercial distribution of ethane and ethane-based raw materials increases, it could trigger new innovations and investment in new technologies. Research and development initiatives leveraging ethylene-based chemistries that replace petroleum-based products may predominate. Companies might also look for longer-term sourcing relationships and partnerships with raw material suppliers to help with developing new products.

"Based on industry reports, we estimate U.S. chemicals industry has invested $15 billion in ethylene production, increasing capacity by 33%. As these investments take hold yielding more supply, the United States could become a major, global, low-cost provider of energy and feedstocks," said Garrett Gee, director of chemical advisory services at PwC. "We're already seeing increased investment activity among multinational companies in building the infrastructure to export liquefied natural gas (LNG) products."

As manufacturers replace petroleum-based raw materials with products based on ethylene, their cost structures should also change significantly, as well as supply and demand for certain products. This pattern may be repeated for other petroleum-based raw materials, many of which are used in building, construction, adhesives, paint, coatings, plastics, packaging and carpeting. If the changes brought about by shale gas take hold in the chemicals industry, they will also create a need for specialty steels, reactors, pumps, valves, fittings, control systems, storage tanks and other equipment, as

well as the services of engineering and construction firms. Another possible outcome is that chemical products will increasingly become a substitute for more expensive materials, such as metals, glass, wood, leather and textiles.

"The significant increase in NGL production could drive change across the U.S. chemicals industry, but the full potential of the market will depend on a number of factors. According to a *New York Times* article by Michael Levi in August [August 16, www.nytimes.com/2012/08/16/opinion/the-case-for-natural-gas-exports.html], these factors include domestic tolerance for expanded hydraulic fracturing and its waste products, as well as the political and economic ramifications of exporting LNG," added Scamuffa. "The implications of the shale gas boom for the chemicals sector also vary by company, so management teams need to consider their individual situation and business options, including the risks and opportunities presented by the abundance of shale gas."

[Courtesy of SustainablePlant.com]

Authors Honored for Alarm Management Book

Eddie Habibi and Bill Hollifield have been recognized as the recipients of the Raymond D. Molloy Award presented by ISA Publications Department for the best-selling ISA book of 2011, *Alarm Management: A Comprehensive Guide*, Second Edition. The annual award is presented to the book that addresses the needs of automation professionals, while meeting the high standards and expectations of the ISA Publications Dept. The book is designed for engineers in refineries and other process plants to help them optimize alarm systems that have been known to contribute to abnormal situations, rather than assist in preventing them.

Eddie Habibi is the founder and CEO of PAS (www.pas.com), a human reliability solutions provider that serves the power and processing industries. Bill Hollifield is PAS's principal alarm management and high-performance HMI consultant.

"Alarm Management: A Comprehensive Guide joins a select few successful publications from ISA that have received this award," said Eoin O'Riain, vice president of the ISA Publications Dept. ■

Ametek Buys Micro-Poise Measurement Systems

Ametek, Inc. has acquired Micro-Poise Measurement Systems, a provider of integrated test and measurement solutions for the tire industry, from American Industrial Partners, a private equity firm, for approximately $170 million in cash.

Micro-Poise is headquartered in Streetsboro, Ohio, and has additional manufacturing operations in Troy, Mich., Beijing, China, and Lübeck, Germany. It has estimated 2012 sales of approximately $125 million.

"Micro-Poise is a great addition to Ametek. It has an excellent reputation within the industry and is the clear global leader in this niche, highly differentiated market. This acquisition further broadens our position in the highly attractive materials test and measurement equipment market and makes us a leader in a growing industry segment," notes Frank Hermance, Ametek's chairman and CEO.

"Driving market growth in both developed and emerging markets is the need for more sophisticated test and measurement techniques due to the increased variety and complexity of tire designs, the globalization of tire manufacturing capacity and more stringent quality requirements," says Hermance. "Micro-Poise is well-positioned to take advantage of that growth. It has a large installed equipment base at many of the world's leading tire manufacturers, and is the only industry supplier of all key test and measurement techniques with products that offer best-in-class accuracy, repeatability and cycle times."

Micro-Poise joins Ametek's Electronic Instruments Group.

ABB Reports Solid Performance in Uncertain Market

ABB reported steady orders and higher revenues in the third quarter of 2012 despite a challenging macroeconomic environment, as the company benefited from what it said was its well-balanced market exposure, especially the improved access to the North American automation market gained through recent acquisitions.

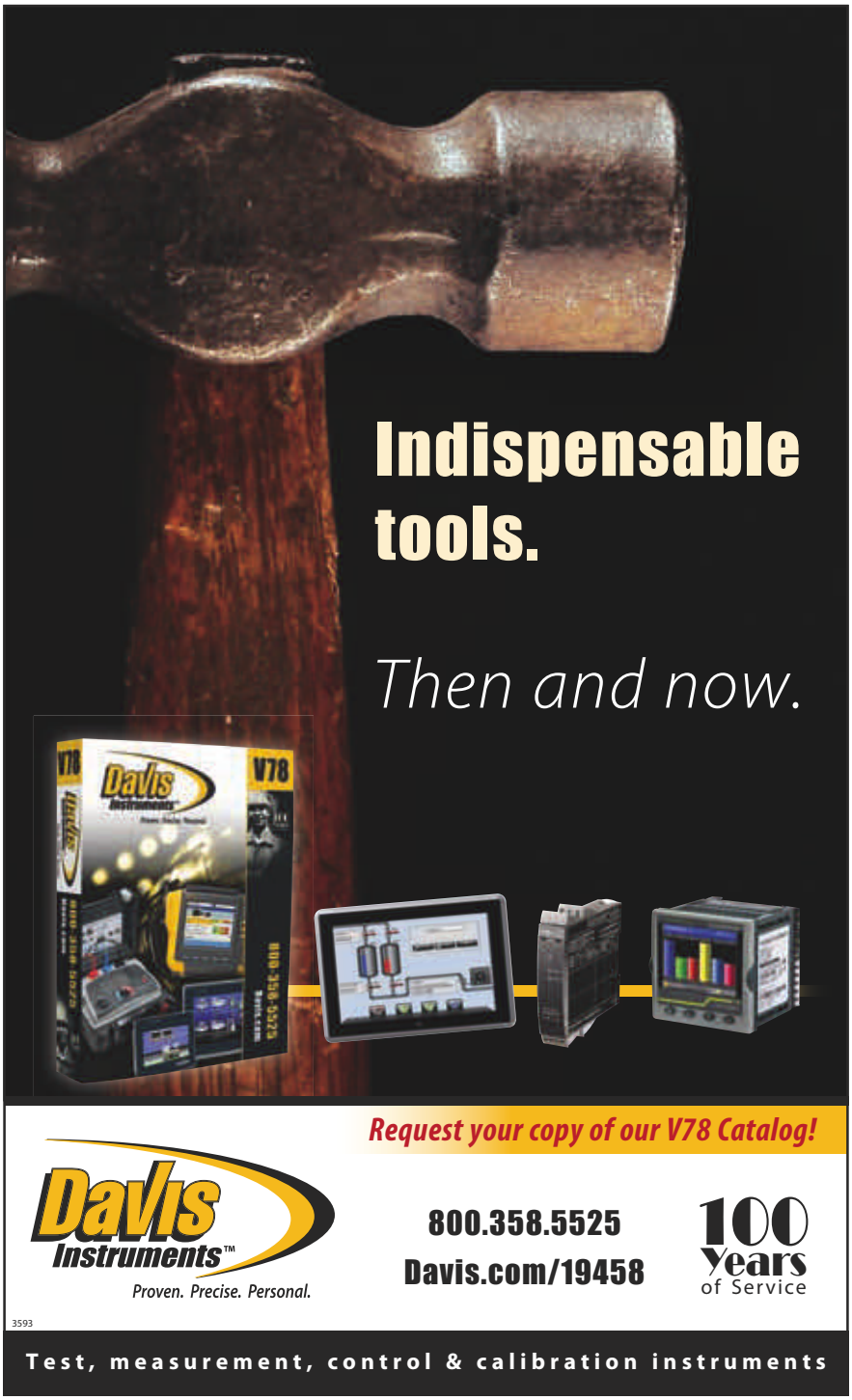
Power orders were lower than the year-earlier period, which included a large offshore wind order. Excluding that order, power orders rose 10%, driven by utility and industry investments in power transmission. Automation orders were up 13% (flat organic), driven by demand for improved industrial productivity, mainly in Europe and North America and in the mining and marine sectors.

The operational EBITDA and operational EBITDA margin were lower than in the strong third quarter of last year, mainly due to the execution of lower-priced power orders from the backlog, but were higher than 2Q 2012. The operational EBITDA margin in Power Products was steady compared to the second quarter of 2012. Cost savings for the group amounted to about $280 million in the quarter. The stronger U.S. dollar continued to negatively impact ABB's reported results.

An increase in divisional cash flows was more than offset by cash outflows

from hedging corporate exposures as a result of the stronger U.S. dollar.

"We're encouraged that we could grow the business and sustain profitability well within our target corridor despite a challenging macro environment," said Joe Hogan, ABB's CEO. "We continued to execute on cost reduction and grow the service business, two of our key strategic initiatives. The geographic rebalancing of our automation business towards North America, for example, through the Thomas & Betts acquisition, is also paying off. That gives us reason for cautious optimism. Short-term market visibility is limited and volatility is high. In this environment, our near-term focus will continue to be on competitive costs and using our strong portfolio and geographic balance to tap profitable growth opportunities."



PI North America Meeting Touts Profibus Gains

The 18th General Assembly Meeting of PI North America, Sept. 26-27 in Scottsdale, Ariz., celebrated Profibus and Profinet gains in market share. According to Executive Director Michael Bryant, "The Profibus market is expected to grow in 2012 by a further 4 million nodes to reach a total of about 44 million. It's reassuring that Profibus continues to flourish even as Profinet is escalating its market share. Today, every fifth device sold is for Profinet, compared to some years ago when it was 1 in 15."

During the part of the meeting focused on the process industries, Hunter Harrington from the Profi Interface Center in Johnson City, Tenn., a North American PI Competence Center, described the Profinet proxy solution that allows sub-networks such as Profibus PA, HART and Foundation fieldbus to be connected to Profinet.

The process theme was later emphasized by Jim Simmons from DuPont who described the fieldbus "learning curve" triggered by his company's purchase of a Siemens PCS7 control system. He sung the praises of fieldbus and Profinet in particular. "Through that project, I have become a fieldbus proselytizer within DuPont, I believe any new control system installation should have to justify *not* using fieldbus technology." ■

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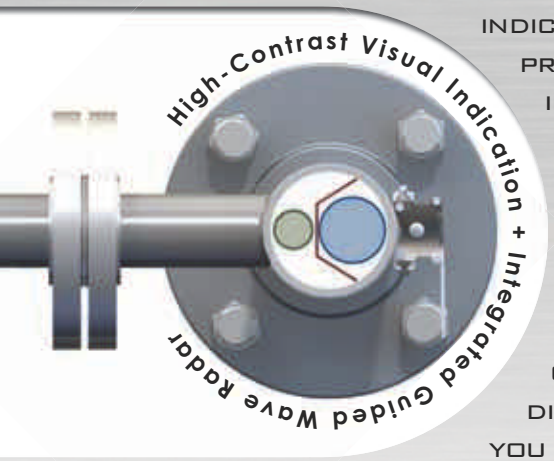

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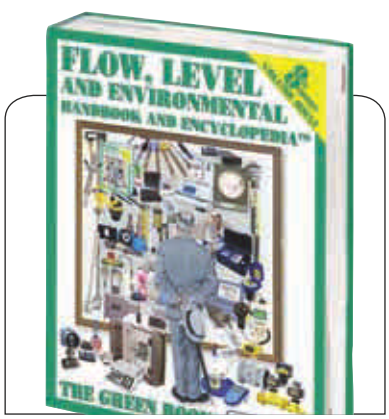

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Two YouTube videos on level measurement subjects. First is "Pneumatic Liquid Level Measurement Loop." This short video shows how a Foxboro model 13A pneumatic differential pressure transmitter is used to measure the level (height) of water inside a vertical tube. In a real application, it would be measuring the height of some liquid in a storage or processing vessel, probably not a tube or pipe. Click on http://www.youtube.com/watch?v=RR1enELOSnU. The second, "Level Measurement Lab (Pneumatic)—Calibration Check," shows how to use the 13 A transmitter to measure water level inside a plastic tube, and report that level as a 3-15 psi air pressure signal to a remote "receiver" gauge. This lab demonstrates the basic operation of any pneumatic signaling system where a variable air pressure represents some other variable (in this case, water level). In the past, most industrial instruments worked like this: using 3-15 psi pneumatic signals to represent pressures, levels, temperatures, flows, and even some analytical variables. Click on www.youtube.com/watch?v=gybq5lkvO_Y.

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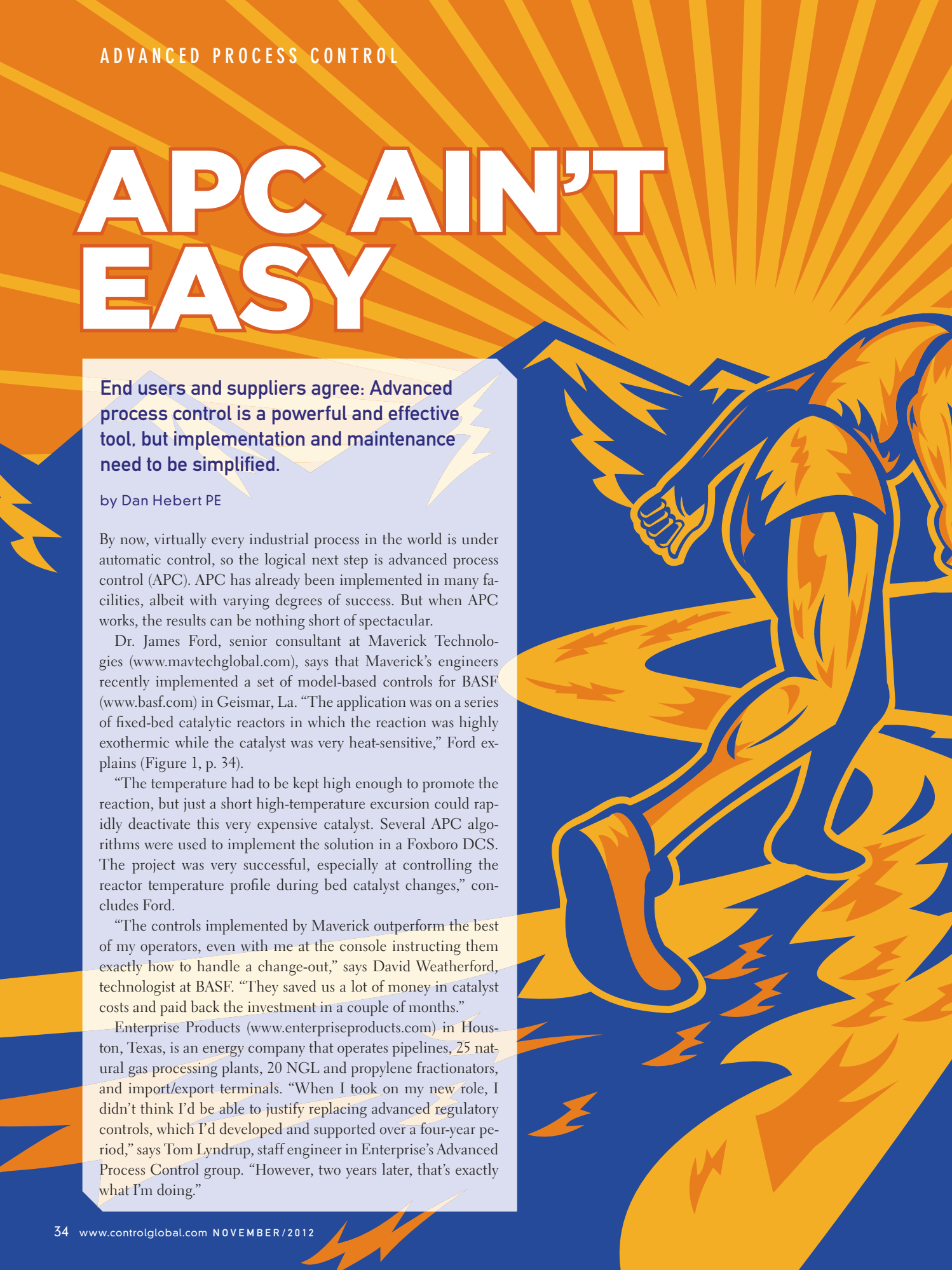
APC AIN'T EASY



End users and suppliers agree: Advanced process control is a powerful and effective tool, but implementation and maintenance need to be simplified.

by Dan Hebert PE

By now, virtually every industrial process in the world is under automatic control, so the logical next step is advanced process control (APC). APC has already been implemented in many facilities, albeit with varying degrees of success. But when APC works, the results can be nothing short of spectacular.

Dr. James Ford, senior consultant at Maverick Technologies (www.mavtechglobal.com), says that Maverick's engineers recently implemented a set of model-based controls for BASF (www.basf.com) in Geismar, La. "The application was on a series of fixed-bed catalytic reactors in which the reaction was highly exothermic while the catalyst was very heat-sensitive," Ford explains (Figure 1, p. 34).

"The temperature had to be kept high enough to promote the reaction, but just a short high-temperature excursion could rapidly deactivate this very expensive catalyst. Several APC algorithms were used to implement the solution in a Foxboro DCS. The project was very successful, especially at controlling the reactor temperature profile during bed catalyst changes," concludes Ford.

"The controls implemented by Maverick outperform the best of my operators, even with me at the console instructing them exactly how to handle a change-out," says David Weatherford, technologist at BASF. "They saved us a lot of money in catalyst costs and paid back the investment in a couple of months."

Enterprise Products (www.enterpriseproducts.com) in Houston, Texas, is an energy company that operates pipelines, 25 natural gas processing plants, 20 NGL and propylene fractionators, and import/export terminals. "When I took on my new role, I didn't think I'd be able to justify replacing advanced regulatory controls, which I'd developed and supported over a four-year period," says Tom Lyndrup, staff engineer in Enterprise's Advanced Process Control group. "However, two years later, that's exactly what I'm doing."

And, despite his initial doubts, Lyndrup is succeeding, especially in projects where APC replaces existing controls. "In some cases, 24 hours after a new APC routine started up, we achieved higher total production than the day before, despite a change in feed composition that normally results in lower rates." (For more on Enterprise's APC accomplishments, see the sidebar, "Justifying APC," at www.controlglobal.com/CT1211_JustifyingAPC.html.)

Tom Kinney, product manager at Invensys Operations Management (www.invensys.com), says, "MPC moves the operating process closer to multiple constraints simultaneously to realize the maximum profit from an operating unit. Units typically pay for themselves within six months and equip companies for ongoing financial, productivity, quality or other strategic advantages."

Given these success stories, why isn't APC implementation more widespread?

APC Is Incredibly Hard

If you saw the movie, "Moneyball," or read the book, you probably remember Billy Beane telling Scott Hatteberg how easy it would be for him to switch from catcher to first base. For confirmation, Beane looks to infield coach and colleague Ron Washington, who doesn't miss a beat when he tells Hatteberg, "It's incredibly hard."

According to end users, some vendors sound like Beane, particularly when they are trying to sell them on overly complex APC implementations that turn out to be incredibly hard to implement and nearly impossible to maintain.

Dan Cox, director of engineering at AOC Resins (www.aoc-resins.com) in Collierville, Tenn., has reservations about off-the-shelf APC. "Most APC products don't work well in our batch environment," he says. "This is in contrast to the vendor's claims, but I still feel this is the case. The amount of engineering required for model-predictive control (MPC) or neural nets tends to outweigh the benefit."

So, AOC Resins implements APC with custom coding and reaps the fruits of its labors. (For more details, read the sidebar, "Roll Your Own APC.")

Lou Bertha, engineer at RDI Controls (www.rdicontrols.com) in Lower Burrell, Pa., is also skeptical. "In my experience, APC is a marketing term big DCS companies use to sell a bunch of preconfigured subroutines that either provide generic or process-specific routines such as soot blowing, compensated gas flow calculations, etc.," he says. "Advanced is questionable. Sometimes these canned routines are just an easy way to develop a system since the specific routine has been developed, but typically end users cannot adjust these routines for their specific application. The ironic thing is what the big DCS houses call APC is what most smaller engineering companies call the next project."

Ford of Maverick agrees. "The glory days of implementing

ROLL YOUR OWN APC

AOC Resins (www.aoc-resins.com) says canned APC doesn't work well with its batch processes, but it is using Emerson Process Management's (www.emersonprocess.com) DeltaV APC software for certain functions and supplementing Emerson's software with custom code.

"We use fuzzy blocks in certain loops that have changing process gains," says Dan Cox, director of engineering at AOC Resins. "However, we don't use them in loops with long dead times. DeltaV Fuzzy works well with changing process gains as long as the dead time is under around 30 seconds. When control is more complicated, it's simply easier to figure out stuff about the process. It's hard to replace an engineer that can do a mass balance and has good APC programming skills."

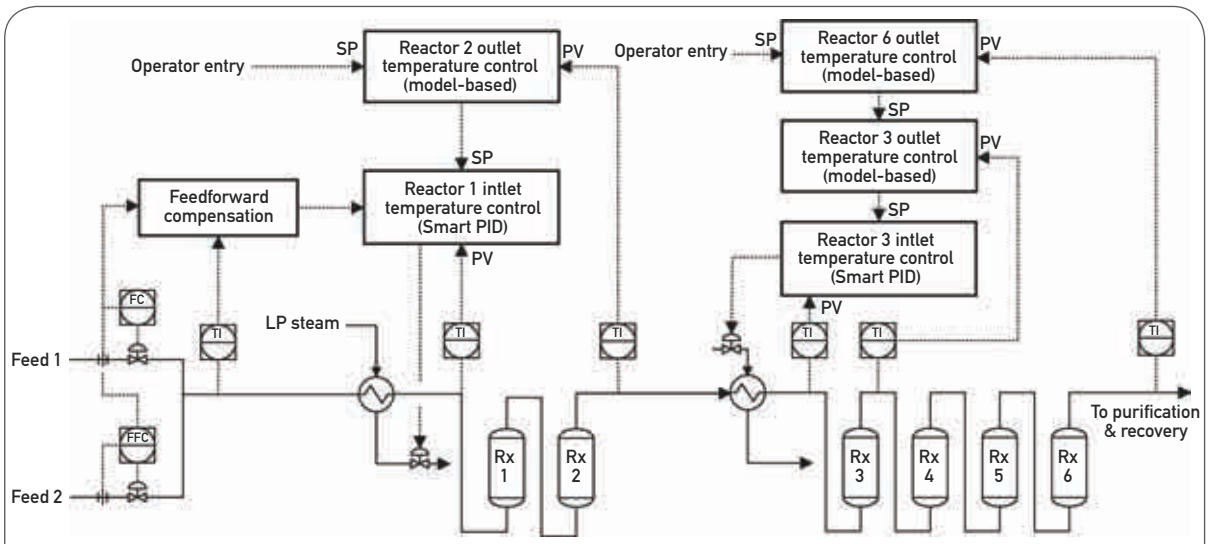
AOC develops its own programming. "Typically we just use Math block within DeltaV," he explains. "The structured text programming language has most common functions you would need, but their variation on an array is weak. If it is too complex, we will send an OPC request to a stored procedure in SQL, have SQL crunch the number and send the result back. From the SQL stored procedure we may invoke a VB script. Basically once we get out to SQL via OPC, we will use any means available in the modern computing world."

Most of the work AOC has done involves curve fitting to model acid value and viscosity relationships in products as they build molecules. "If we're off the expected curve, we adjust by using models to get us back on the curve by adding acids or glycols," he explains. "The math involved here is beyond what makes sense to do in DeltaV. Because of this we use model data stored in SQL with stored procedures to send results to the control system."

Cox would like to see some improvements in APC software data exchange. "Once data can be pushed and pulled with SQL commands, you no longer need to have the Emerson guy come in and spend hours on setup," he notes. "Pushing and pulling via OPC is OK, but why not embed database functions in the programming environment? Flagging data as valid with a IF statement in the control system as it goes to the database would be easier than all the tools that are currently offered to slice the right piece of data."

The math is not that complex, he says. "I expect to see more canned packages for equipment that is common in our industry. Every chemical plant has thermal oxidizers, scrubbers, columns and so on. This equipment usually comes from a handful of vendors. So I should be able to choose an Alfa Laval model XXX, for example, and have an MPC block almost configured to optimize the unit."

The powerful programming environments provided by vendors mixed with good engineering principles can yield excellent results, but a high degree of end-user expertise is required.



Courtesy of Maverick Technologies.

APC DOES CATALYTIC REACTORS

Figure 1. APC was used with great effectiveness by system integrator Maverick Technologies to improve control on a series of fixed-bed catalytic reactors.

MPC on every process in a refinery or chemical plant are over," he says. "Too many failures. The future will see a renewed interest in APC solutions tailored to fit each specific control problem, and will rely on a combination of traditional advanced regulatory control, inferred properties and MPC techniques when appropriate and justified."

Maintaining APC's full effectiveness is also difficult. APC will only work as designed for a limited period of time, as the underlying process conditions on which the original implementation was based are continually changing to one degree or another in every process plant.

In a refinery, for example, a switch might be made in the product mix in response to customer demand. Raw material input properties can vary significantly, particularly if

AERO-DERIVATIVE ADVANCED CONTROL

What's APC and what's just a collection of clever programming blocks? Lou Bertha of RDI Controls (www.rdicontrols.com) isn't sure, and he's the one who put together an "APC" system to control an aero-derivative combustion turbine. The process is basically a jet engine exhausting into a power turbine, with the power turbine coupled directly to a generator.

The system must control and limit multiple jet engines, coordinate the speed to 3600 rpm to synchronize with the electrical grid, and adjust load when online. Each of the engine controllers positions the fuel control valve to provide the required liquid or gas fuel requirements, and that's where it gets interesting.

With two engines operating, the system will determine which engine is the master. The slave engine will get an engine speed cascaded setpoint from the master. Either engine controller can be the master, and the control logic seamlessly switches masters as operational modes dictate.

The system is controlled with four Opto 22 rack-mounted Snap PAC R-series controllers with I/O modules. Controllers are installed on each of the engines. The controllers communicate with each other peer-to-peer to ensure overall operational requirements are met.

"Both systems have multiple PID controllers, including cascaded control loops, which all vie for control of the fuel control valve," explains Bertha. "Tracking and coordination between these controllers can become quite complex, because we need the controllers to respond immediately when needed and not have to wind down."

In multiple engine configurations, they need each engine to control its fuel flow to maintain precise speed and load control of the generator. Multiple modes of operation and tracking complicate things further. "We can put one engine in a test mode, which allows direct control of engine speed, or have one engine shut down due to engine problems, while the other engine maintains the specified generator setpoints," Bertha notes.

The system uses advanced control techniques such as cascade control loops with and without feed-forward, adaptive tuning, anticipatory control adjustments and multiple controller coordination and tracking.

"Opto22 allows us to develop user-defined subroutines, which can range from simple to complex," says Bertha. "These subroutines are developed in the same flow diagram/scripting language used to develop the control logic. Since Opto22 provides both higher and lower level commands, we have the ability to develop the blocks or subroutines, such as rate limiters, function generators, monitors, Modbus commands and so on, to suit our needs."

But is this APC? "Some of these blocks may be considered standard on some DCS type systems, but the Opto22 setup allows us to develop and modify these subroutines to provide greater flexibility than the 'fixed' routines in other systems," Bertha explains. "You don't need to be a computer science major to figure out and modify these routines to suit your needs. Whether or not these are considered APC is in the eye of the beholder, but the tracking and coordination between PIDs and setpoints makes it a fairly advanced setup," says Bertha.

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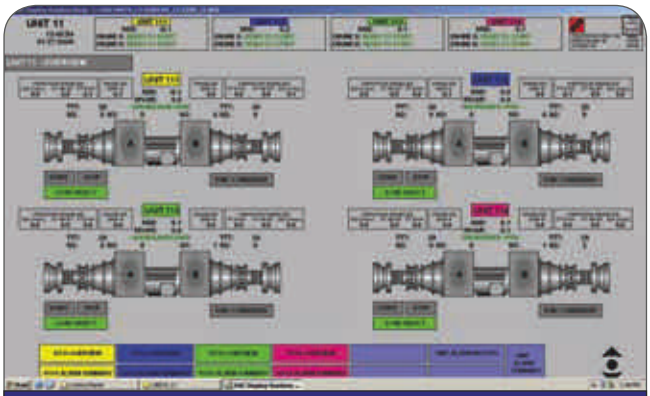

Courtesy of RDI Controls.

Figure 2. System integrator RDI Controls uses standard software tools provided by Opto 22 to create its own APC routines to control combustion turbines.

suppliers are changed. Adding new equipment can significantly change the process, as can normal deterioration of existing equipment.

As changes occur within the process, corresponding adjustments need to be made to the APC algorithms and models. Without this on-going maintenance, the original APC application will lose effectiveness, often to the point where it must be decommissioned.

Without Maintenance, Benefits Fade Away

Whether model-based or some other underlying technology, any APC implementation will lose its effectiveness over time if it's not properly maintained. Maintenance doesn't require as much effort as initial implementation—step-testing isn't generally required, for example—but adjustments must nevertheless be made to maintain effectiveness.

Richard McCormick, automation engineer and industry consultant with Mick Automation in Quebec City, Canada says MPC maintenance is and will continue to be the biggest issue. "Degradation of performance over time after start-up is seen everywhere, thus benefits decrease over the years," he points out. "Automatic monitoring tools for MPC applications are oriented for detecting things like models mismatch, the percent of the time constraints are hit, and other measurements to flag and identify causes for MPC performance degradation over time. Lack of experienced personnel for good support remains the biggest challenge for users. This is one reason why using specialized firms seems to be popular."

Mick Automation implemented MPC on FCC polymerization units in the late 1990s, and it took a couple of

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years to complete it. That was the easy part. "The major thing after implementation is to maintain this huge application with knowledgeable process engineers and to have the operators understand and believe in the moves made by the optimizer," he says. "When the process engineer who participated in its design and implementation changed position, the application slowly and continuously degraded to a point where it was decommissioned. This is why I would now stay away from this type of optimization unless you have an impressive and knowledgeable staff to maintain it."

An automation engineer at a major refiner, who wishes to remain anonymous, says getting a multi-variable control (MVC) application running isn't too much of a problem. "Just spend big money to hire an expert," he advises. "The problem has always been keeping it running once the expert goes home. If the vendors were listening to their customers, you would see more support tools for running applications, better visibility into why a controller did something unexpected, the ability to identify poor performing models in real time and user-friendly tools to update individual models inside a running application."

Making APC Easier

End users are making APC easier by going back to basics, often implementing APC functionality by creating custom configurations using standard programming tools provided by automation system vendors.

Todd Gionet, process control engineer at Agrium Carseland Nitrogen Operations (www.agrium.com) in Denver, Colo., uses an Invensys Connoisseur advanced process control application (http://tinyurl.com/9mgq3xp) with an MPC configuration and a linear programming optimization layer that provides target information to the constraint controller.

In the midst of all the advanced APC software, Gionet uses some straightforward controls too. "For example, we run an advanced servo control cascade incorporating feed-forward control. Dead time compensation is faked with an adaptive first-order filter block. We currently have one important PID loop running a self-tuning algorithm.

"I might be too liberal in terms of what most control engineers consider advanced control, but keep in mind that cascade control was once considered advanced control," he says.

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Bertha of RDI Controls, agrees. He used user-defined subroutines to control combustion turbines. While the integration of multiple PID loops was a challenge, the individual control loops are fairly simple. "The blocks we created wouldn't be considered advanced by most engineers, but they allow us to easily add functionality and simplify the overall logic configuration," he says.

"Is this an APC type of system?" he asks. "Depends on your definition of APC. If you are looking for advanced from a control perspective then yes; if you're looking for canned routines that say they are advanced, then no."

In many cases, the more esoteric varieties of APC aren't needed. "We often make advanced control more difficult than it has to be," our anonymous engineer opines. "For example, I do pass-balance control with PID blocks—very simple. I am continually amazed at the number of people who poo-poo the idea, don't believe it can be done, and/or insist on writing some fancy code or use an MVC to do what is essentially integral-only control, and very slow integral control at that.

"The user community has to take greater ownership of technology selection. If you rely on a vendor, you're going to get what he is selling. If management has been sold that MVC is

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TABLE 1: BENEFITS OF APC

1. More throughput
2. Improved quality
3. Less variability
4. More stable operations
5. Allows operation closer to process limits
6. Can be used to justify capital expenditures
7. Improves and standardizes operator actions

TABLE 2: HOW VENDORS CAN MAKE APC EASIER

1. Create templates for popular process equipment and units
2. Create canned routines for common applications
3. Stop promoting the use of overly complex solutions
4. Create tools that allow users to easily create their own APC solutions
5. Provide tools that alert users when application maintenance is needed
6. Integrate APC more tightly with regulatory control
7. Make it easier to exchange data with external APC-related applications
8. Provide a forum where users can swap APC programs

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APC, then it makes it impossible to apply simpler, possibly better—or at least more cost-effective—tools to do the job."

End users are doing their part to make APC easier, and vendors are moving in the same direction. (Table 2 lists some of the improvements APC vendors could make to keep end users happier.)

Vendors on Board

Vendors are very aware that APC needs to be easier, and they are responding by adding features that speed and simplify implementation, and by providing maintenance tools that alert end users when adjustments to existing applications are required.

Kinney says Invensys is working to make its software easier. "In general we foresee tools which make it easier to configure and maintain controllers and will get more intuitive and easier to use. A part of this trend is an improvement in performance monitoring and diagnostic tools to help both the engineer and the operator to understand what the controller is doing and why. Some processes require nonlinear techniques, and we see this as improving in the future as well."

Robert Golightly, APC manager at AspenTech (www.aspentech.com), says, "Traditional maintenance issues will be eliminated with built-in technology that automates much of the maintenance cycle and keeps controller models matched with plant performance, all without the need for the level of expertise required today."

Perry Nordh, product manager at Honeywell Process Solutions (www.honeywellprocess.com), says Honeywell has a system in place to help end users implement APC. "Benefits Guardianship Maximum (BG Max) is a flexible and comprehensive service program that provides APC performance management services to help plant managers maximize the return on investment from Honeywell's advanced control and optimization solutions," he explains.

Other APC vendors offer similar support services, but users also want vendors to make APC easier for them to use without having to rely on supplier support.

"Opto 22 doesn't focus on many HMI setup tools or application-specific algorithms, although many users and vendors sell or share industry-specific tools for our PAC Control programming software," says Tom Edwards, Opto 22's (www.opto22.com) senior technical advisor. "The tools that users and vendors provide for the PAC Control programming software are primarily in the form of subroutines, which are imported into PAC Control and incorporated into a control program. Opto 22 provides subroutines as free 'integration kits' on the website. Other subroutines are shared by customers in the online OptoForums," he adds.

"APC will become available anytime, everywhere, because the basic operations data and software are easily available at the DCS and PC level," says Saravanan Prabakaran, solutions consultant at Yokogawa (www.us.yokogawa.com). "The implementation and maintenance cost of APC will become cheaper. The tools that will be available for APC implementation will help in easy implementation."

The optimal solution is elusive, but perhaps the most promising path is to start with the simplest APC possible, one that delivers an acceptable percentage of theoretical benefits, but without stultifying complexity. Users and vendors alike must keep in mind that implementing APC is just a start because, without proper maintenance, any solution will soon lose its effectiveness. Even with complex APC technologies, simpler is often better. ■

Dan Hebert PC is Control's senior technical editor.

[An extended version of this story is at www.controlglobal.com/CT1211_CoverStory.html.]

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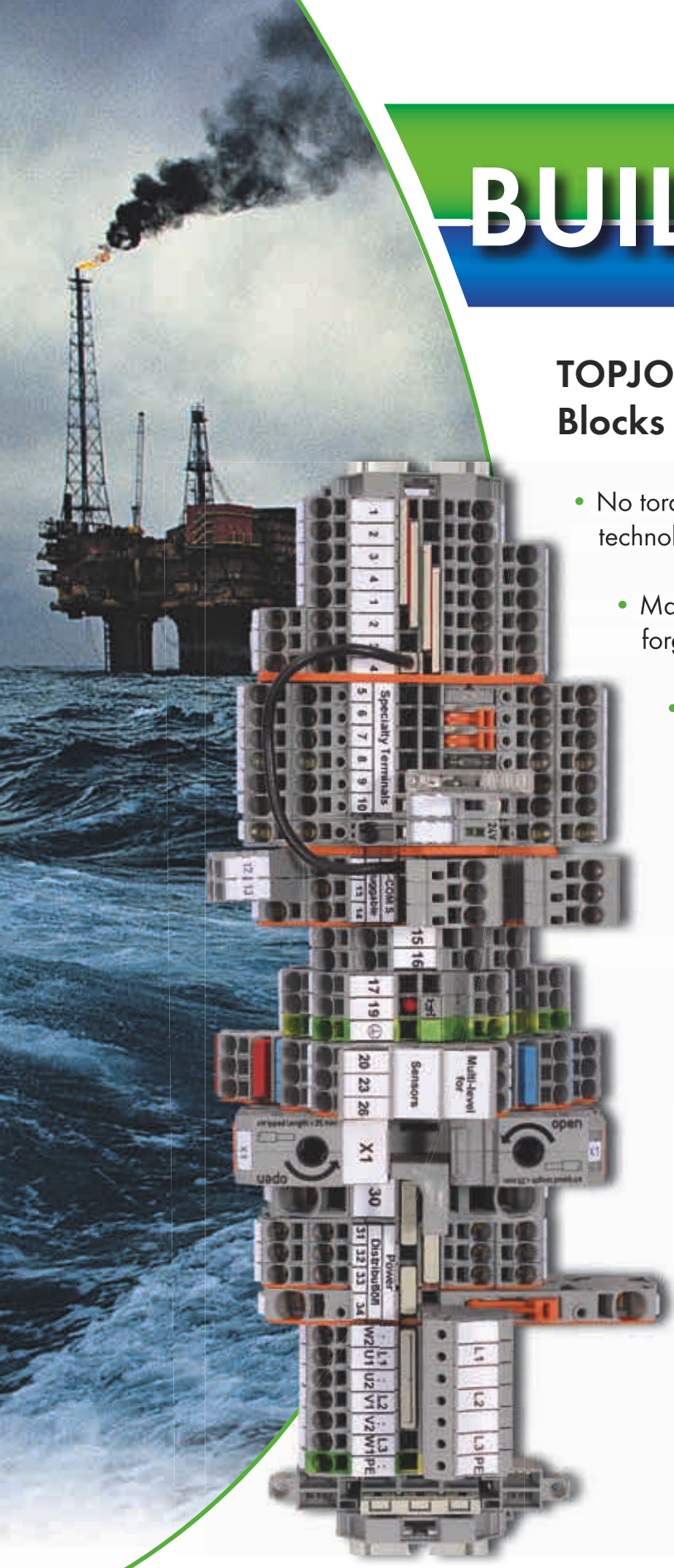

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Finding Faults

Giant Swedish mine counts on an integrated EAM system to make fault reporting and predictive maintenance easier.

by Nancy Bartels

Some 50 km north of the Arctic Circle in the Lapland region of Sweden is a giant hole in the ground. It's 3 km long, 1.5 km wide, and 250 m deep. This is the Aitek copper mine. About 15 km from the town of Gällivare, it is one of the largest open pit mines in Europe.

Owned by the Boliden Group (www.boliden.com), which operates mines and smelters in Sweden, Finland, Norway and Ireland, the mine recently completed a massive expansion and modernization project. The price tag for Aitek's upgrade was $790 million, but it's enabled the mine to double its production capacity, extend its life until 2030 and add molybdenum to its list of metals produced.

Aitek's ore is not especially high-grade. It's 0.25% copper, 0.1 g gold per ton and 2 g of silver per ton, but still worth the investment in digging it up. It's not just the market value of the minerals that makes the investment worthwhile. The upgrades Boliden has installed are expected to reduce life-of-mine cash costs from $0.80 per pound to $0.43 per pound, and have raised production rates from 4.3 tons per man hour to 5.5 tons per man hour. Efficient, trouble-free operation is crucial to Aitek's long-term success.

Crush, Shake, Stir

Once a week at Aitek, a blast produces enough ore for the operation to process 106,000 tons each day. The unprocessed ore is loaded onto 100-ton trucks, which deliver it to a crusher deep in the pit. The crusher reduces the ore to 30-cm boulders, which are then transported by underground conveyors to a storage area above ground. From there, a 7-km conveyor moves the rock at 4 m/s to the concentrator

THE EQUIPMENT LIST

The modernization project at Aitek is appropriate to the size of the mine itself. ABB (www.abb.com) has provided:

- 650 motors for conveyors, pumps, fans, crushers, grinders and process equipment
- 230 drives and variable-speed drives to control the electric motors
- Two 22.5-MW, gearless mill drives to power grinding mills
- Two 2 x 5-MW, dual-pinion drive systems for ring-gear mill drive (RMD) mills
- Four 1.4-MW, permanent-magnet motors for slurry pumps
- Process control system (Extended Automation System 800xA)
- 23 distribution transformers for drive systems
- Three 80 MVA power transformers for substation
- Gas-insulated switchgear (170 kilovolt) for substation
- Harmonic filter system for the complete plant
- 201 cubicles of low-voltage switchgear (400-690 volts) for distribution of power across the site.

plant, where two 22.5-MW gearless mills grind it down to sand at the rate of 4400 tons per hour.

Then the sand goes into flotation tanks filled with reagents, foaming agents, compressed air and chalk, where 500,000 liters of water are added each hour. This treatment separates out the valuable copper, gold and silver ore, which floats to the top. The resulting chalcopyrite concentrate, which is 25% copper, is then transported by train to Boliden's smelter in Rönnskär, 400 km away.

A BIG DAILY GRIND

Figure 1. One of two 22.5-MW gearless mill drives that power the grinding mills at the Aitek mine.

An operation this size has a lot of equipment to be maintained. In addition to the new concentrator, surface crusher and the 7-km conveyer between them, the site has pipelines to its water reclamation stations, pumping stations, a welding shop, a truck garage, administration buildings and a recycling station.

The operation is controlled by a System 800xA from ABB (www.abb.com), and to support maintenance of the facility, designers integrated a Maximo enterprise asset management (EAM) system from IBM (www.ibm.com) with it.

Finding Faults

Among the goals Boliden had for the system was to increase the number of reported faults in the system. At first glance, this seems counter-intuitive; one would think the goal would be to reduce faults. But in fact, unreported faults don't get addressed. In the past, using the old solution, operators tended to avoid the complicated, time-consuming reporting process and simply didn't report all the faults they observed.

Now, because System 800xA provides a common visual interface for a diverse assortment of systems, applications and equipment, operators simply click on the object shown on their HMI that they want to report, choose "create fault report," input the problem and submit the report, which

EASIER FAULT FINDING—AND REPORTING

Figure 2. The integrated report application from Maximo makes it simple for operators to report faults as they are discovered right from their HMI screens.

then becomes available in Maximo, where the maintenance staff can see complete and correct information, and take action immediately.

The integration of Maximo and System 800xA ensures early fault detection, which has increased the number of faults reported five-fold, according to Aitek. It gives operators the ability to inform the maintenance department about problems while they're still small, and before they can cause a breakdown or an unplanned shutdown.

The mine and its equipment runs 24/7 every day of the year in extreme conditions. As is typical in open-pit operations, it's very dusty. It's also very cold and dark much of the year, and outdoor equipment has to withstand temperatures as low as -45 °C (-49 °F) in winter. The reliability of motors, drives and other equipment is paramount in such conditions—another reason early fault detection is critical.

At Aitek, maintenance is supported not only with the EAM system, but also with the document management system, which is integrated with System 800xA. This gives operators access to drawings, instructions, manuals and other documentation to enable quick and correct actions. In March 2011, Aitek also began using the asset monitor function in System 800xA to support its predictive maintenance activities.

The asset monitors focus on critical parts of the operation that are essential for reliable and profitable operation of the mine. One of these is the gearbox of the large mills. Asset monitors signal the need for maintenance on them, detect anomalies, and take corrective action before a critical situation arises.

Aitek uses one of the extensions available for System 800xA, Snapshot Reports, to keep track of maintenance issues. Preconfigured reports are executed on a regular basis to collect process and maintenance data. "The 800xA standard functions and other system extensions like Asset Monitoring can provide general and specific report functionality. The flexibility of Snapshot Reports gives us the ability to create system reports based on practically any personnel group request," says P-O Lundqvist, senior project manager at Boliden.

Boliden plans to implement the Asset Optimization solution at all of its mines when their 800xA systems are upgraded. ■

Nancy Bartels is Control's managing editor.

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High Performance Solutions

Is Your Control Valve an IMPOSTER?

Beware the disguised positioner.

By Greg McMillan

When I was leaving home for the first time, my dad said, "Be as honest as the day is long, and don't be fooled into using on-off valves as control valves." I was puzzled since I was only going to summer camp. Years later I realized that my Dad was warning me about the greatest hoax of the century in the automation business. Positioners were put on piping valves and sold as throttling valves. Who wouldn't want a lower-priced valve that was in the piping spec and had the name "High Performance" because of an exceptionally low leakage classification? The valve could serve as both a throttling valve and isolation valve. What a deal!

Users did not realize the flow characteristic was sometimes quick-opening and in many cases, too flat for large openings. Even more insidious was that the backlash and stiction was more than an order of magnitude larger than valves originally designed for throttling service. Adding insult to injury, poor precision pistons (e.g., link arm, rack and pinion, and scotch yoke) and less expensive positioners (e.g., spool instead of relay type) were used that deteriorated the resolution by a factor of five or more. The result was a dramatic increase in nonlinearity, dead time, response time, dead band and stick-slip.

Users were clueless as to the source of the limit cycles and increased process variability. Pneumatic positioners offered no position readback. Even more deceptive was the fact that many installations of smart positioners had actuator shaft rather than internal closure member position feedback. The actuator shaft would move even though the closure member did not. Diagnostics and response test metrics from the positioner said things were not too bad. The smart positioner was basically lying.

Nearly all control loops in the chemical industry depend upon the manipulation of flow by the use of a final element such as a control valve. It's generally taken for granted that, when a controller changes its output, there's an actual change in the position of the closure member of the valve (plug, ball or disk). However, the specification of control valves doesn't adequately emphasize the very basic requirement that the positioner respond in a timely manner or even at all, and this has resulted in shortcomings that introduce variability into the process.

Before the advent of smart HART and fieldbus positioners, feedback measurements of position were rare because a separate position transmitter had to be installed and wired. The user generally wasn't aware that differences in valve, actuator and pneumatic positioner design were the source of cycling in the process.

Typically, besides traditional factors such as size and materials of construction, control valve specifications have focused on minimizing leakage through the valve at shutoff and emissions to the environment from packing. Too often, to reduce project costs, plants pick on/off valves to address requirements. This can create performance problems that can't be fixed simply by adding a smart positioner. While installing

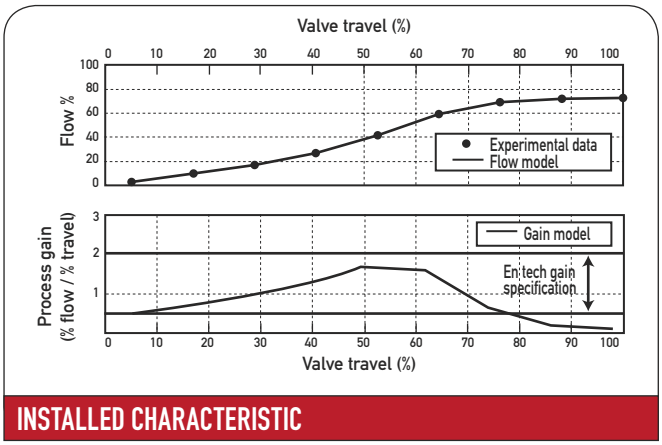

Figure 1. Process gain becomes too low when travel of sliding stem valve exceeds 80%.

a smart positioner is always beneficial, an incorrect feedback mechanism in the valve design can give a false indication of performance.

To avoid problems, always consider five basic valve requirements—linearity, dead time, response time, resolution and dead band. They can give crucial guidance and justification for a final element that leads to better control. Rangeability and sensitivity also are important, but, as we'll see, properly meeting the other requirements will address them.

Linear in a Nonlinear World

To get on a common basis, we need to define process gain for a self-regulating process as the final percent change in the controlled variable divided by the percent change in valve position. Note that the calibration span of the transmitter for the controlled variable is a factor. Because the changes seen in data historians for process variables are in engineering units, they must be converted to percent of scale. The maximum allowable controller gain is inversely proportional to the process gain.

The process gain for flow is the slope on a plot of percent flow versus percent valve position (travel). The plot should reflect the installed flow characteristic, not the inherent trim characteristic. This accounts for the reduced pressure drop available to the control valve at higher flows, because of the increase in pressure drop in the rest of the system from frictional losses and a decrease in pump discharge pressure. The changing valve drop makes an equal-percentage trim more like a linear characteristic, and a linear trim more like a quick-opening characteristic. The effect increases as the valve pressure drop as a percent of the total system pressure drop is decreased.

In Figure 1, we see the process gain gets too low for travel above 80% of a sliding stem valve. The control loop must make large changes in position to change the flow. For similar conditions, a ball or butterfly with a 60° maximum rotation would see a corresponding excessive loss of sensitivity at about 60% travel, a typical problem for high-capacity valves.

If the pressure drop across the control valve is large compared to the pressure drop in the rest of the system, as in pressure letdown, reagent, surge and vent valves, the installed characteristic is the inherent characteristic. For an equal-percentage trim, the nonlinearity is extreme (process gain can change by a factor of 50) because the slope of the characteristic is proportional to flow. If a pH loop directly throttles a reagent valve on a static mixer, this change in slope on the valve characteristic compensates for a change in process gain for pH that is inversely proportional to flow.

A quick-opening trim characteristic provides initially a very high process gain followed by a very low process gain. This nonlinearity is accentuated in the installed characteristic and is generally undesirable because it magnifies resolution problems near the seat, and causes an excessive loss of sensitivity even at mid-range throttle positions. Pinch valves and isolation valves designed for on/off service tend to have this characteristic.

Turning on a Dime or at Least a Quarter

Dead time and response time quantify dynamic response. The dead time, Td, is the time to a first change in closure member position after a change in signal. The response time, T86, is the time required for the position to reach 86.5% of its final value and includes the dead time. These parameters are defined in the ISA standard and report for the test and measurement of the response of the complete control valve assembly.

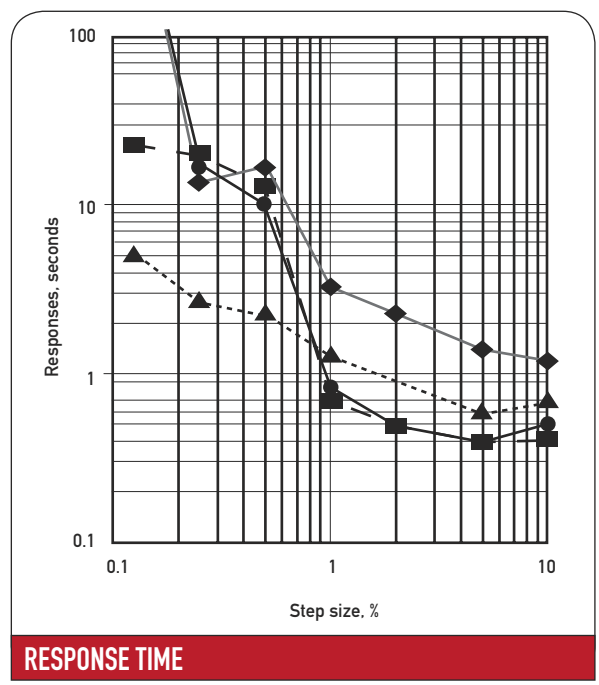

Figure 2. Various positioners on small actuators all exhibit much longer times for smaller step changes.

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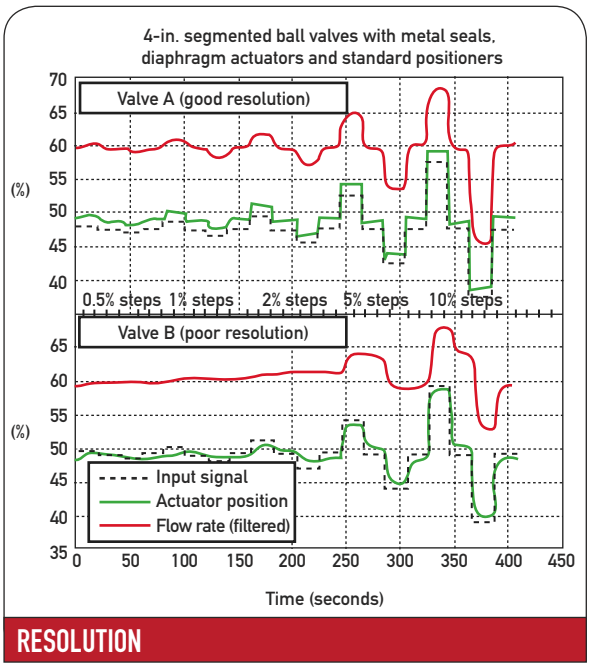
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Valve B (poor resolution)
(%)
0.5% steps 1% steps 2% steps 5% steps 10% steps
Input signal
Actuator position
Flow rate (filtered)
Time (seconds)
RESOLUTION

Figure 3. Even at mid-throttle the flow through Valve B only responds to larger-than-normal changes in the input signals.

If you're looking just at the actuator, you can estimate the pre-stroke dead time and stroking time from an individual fill or exhaust parameter for the actuator type, and volume divided by the fill or exhaust flow coefficient for the positioner, I/P or booster. The response time for large changes is estimated as 86% of the desired change in valve position (%) divided by the slewing rate (%/sec.). For changes between 1% and 10%, the actuator response time becomes relatively fixed, except for large valves and dampers.

It always was rather obvious that large valves were slow because it takes time to fill or exhaust enough air in a large actuator volume to make a change in actuator pressure large enough to overcome the torque or friction load to move the closure element. However, until recently, it wasn't known that the response time of even small valves was dramatically slower, to the point of almost no response, because of the design of pneumatic positioners.

Figure 2 (p. 50) shows how the response time increases to 10 to 100 seconds from 1 to 2 seconds as the size of the step change in signal decreases below 1%. Note that in this plot we are primarily seeing the effect of the positioner because the step changes aren't big enough to see stroking-time limitations.

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Spool-type positioners have an extremely slow response, to the point of no response for changes less than 0.2%. The response time for even good positioners can rise by an order magnitude for small steps.

HART and fieldbus digital positioners generally have eliminated this positioner resolution problem. When you also consider that pneumatic positioners tend to lose their calibration and have no position feedback or diagnostics, there's considerable justification in terms of performance and maintenance for replacing such positioners.

In the days of analog control, a guideline advised using boosters instead of positioners on fast loops. With digital process loops and smart positioners, this no longer is an issue. It's essential that every control valve have a smart digital positioner. A booster, if needed on a large actuator to reduce pre-stroke dead time and stroking time, should be installed on the outlet of the positioner with the booster bypass adjusted to prevent cycling by allowing the positioner to see a small portion of the actuator volume.

Achieving Fine Results

Resolution and dead band play a crucial role in valve response and highly depend upon the total valve package. Resolution is the smallest change in signal in the same direction that will result in a change in position. Pneumatic positioners can adversely affect this, but an even bigger potential problem originates from friction in the packing and seating through a behavior known as stick-slip, where the valve closure member doesn't move (sticks) and then breaks free and jumps to a new position (slips). Older designs of high-temperature and environmental packing, as well as manual tightening of the packing beyond specifications can cause the resolution to deteriorate to 10% or worse.

A more insidious source of resolution problems is the high seat or seal friction particularly associated with valves designed for isolation. On/off (block) valves aren't control valves and vice versa. If an application must prevent leakage, install an on/off valve whose action is coordinated with the opening and closing of a control valve. If a valve must operate near the seat due to rangeability requirements, it's essential to ask the vendor for resolution measurements near the seat.

Don't rely on stated resolution because this normally is for the valve at

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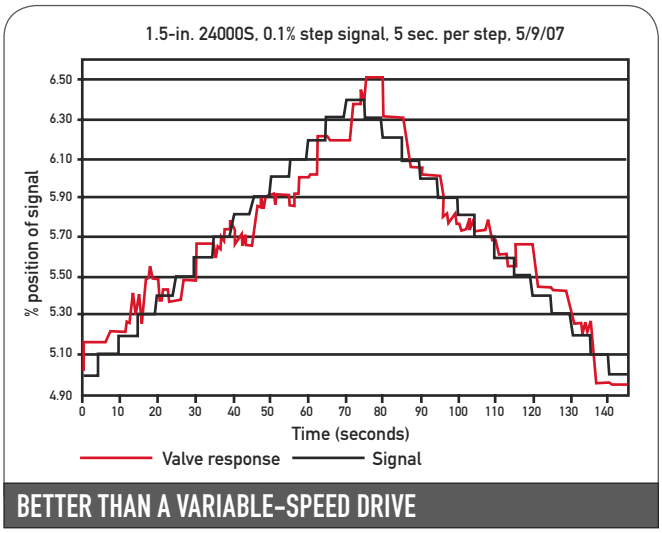

Figure 4. A sliding stem valve with a digital positioner can provide high resolution near seat.

mid-position where the seating or sealing friction is lower. High friction and the discontinuity in process gains near the seat cause loops to oscillate around the split range point where there is a transition from one valve to another. The realistic rangeability of a control valve (the largest flow divided by the smallest controllable flow) is set by the installed characteristic and resolution near the seat. Furthermore, repeatability isn't as important as the ability of the valve to respond, as the process loop will correct for changes in the magnitude of the response.

Dead band is the smallest change in signal in the opposite direction that will result in a change in position. The dead band also is known as backlash or lost motion because it primarily originates from shaft connections and linkages. It's particularly noticeable in rotary valves when there's a translation of linear motion of an actuator to rotary motion of the ball or disk. Don't count on rotary actuators as a solution; these actuators typically have been designed for on/off service and consequently don't generally provide adequate resolution and dead band specifications. The effect is aggravated by high sealing friction and may result in shaft windup where the actuator shaft twists, but the closure member is stuck and then considerably overshoots the desired position when it breaks free.

Particularly insidious on a rotary valve is a digital positioner feedback that uses actuator shaft position rather than closure member position, because the positioner can think the valve moves when the ball or disk sticks. The response for Valve B in Figure 3 (p. 52) shows how such a positioner sees a change in position for step inputs of 1% when, in fact, the flow hasn't changed until the step inputs are 5%. For some rotary on/off valves made into control valves by putting on a digital positioner, the actual dead band was 8%, even though the smart positioner had extensive data showing the dead band was 0.5%.

Resolution and dead band add a dead time to the loop beyond that due to the actuator and positioner. This can be estimated as the resolution or half of the dead band divided by the rate of change of the controller output. Resolution will cause a limit cycle (constant amplitude, persistent oscillation) in any loop regardless of tuning. For an integrating process, such as level with a controller with integral action or a cascade control system where both the primary and secondary controller have integral action, dead band also will cause a limit cycle.

The amplitude of these cycles is the resolution or dead band multiplied by process gain for the process variable of interest. For temperature and pH loops, this process gain can be 10 or more, and can cause severe oscillations and process problems. Whereas problems from nonlinearity and response time are triggered by disturbances and tend to die out if the controller is properly tuned, limit cycles are continual. A digital positioner with good closure-member feedback that is tuned with a high gain and rate action can reduce the amplitude of the limit cycles significantly.

For pH control, the resolution of a reagent valve can determine the number of stages of neutralization needed. A fine adjustment valve in parallel with a coarse adjustment valve simultaneously manipulated by a model-predictive controller can extend the sensitivity and rangeability of a reagent system enough to eliminate a stage.

Throttle Your Valve Problems

A control valve package is only as good as its weakest link, whether it's the actuator, positioner, feedback mechanism, packing or valve design. If the control valve and actuator are similar to those used for isolation valves, you're a candidate for significant limit cycles (sustained variability) in your process. This is particularly a problem with packaged equipment (skids) where control valves are chosen based on piping specifications and lowest price rather than on loop performance. Cost-effective solutions exist.

For example, a sliding stem valve designed for minimal seating friction and packing friction, coupled with a diaphragm actuator and a smart positioner, can reduce resolution and dead band to better than what you can achieve with a standard variable-speed pump. Figure 4 shows that even operating near the seat, a sliding stem control valve with a digital positioner can respond to changes as small as 0.1%. ■

Greg McMillan is a member of the Process Automation Hall of Fame.

[Editor's note: This article is adapted by the author from one that appeared in Chemical Processing, *October, 2007.]*

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Answers for industry.

APC—Complex Solution for Complex Problems

DAN HEBERT
SENIOR TECHNICAL EDITOR
dhebert@putman.net

Advanced process control (APC) can be a very powerful tool to solve problems not amenable to more basic techniques such as PID control. In the right situation, APC can deliver benefits that more than compensate for the time and expense required to implement and maintain these often complex solutions.

For example, Saudi Aramco's six gas plants use AspenTech's (www.aspentech.com) DMCplus APC software to improve unit stability, balance and optimize feed rate, and reduce steam and power usage. In the NGL Fracionator liquid recovery unit, improved quality, increased recovery rate and minimized feed disturbances resulted in a fuel gas savings of about $200,000 per year. Similar improvements were made in the propane recovery units and depropanizer units.

Results were even more impressive at a GALP Energia hydrodesulphurization plant in Portugal, where APC generates savings of about €1.2M ($1.54 million) per year. The AspenTech APC software in use there controls sulphur in the final product to below the spec limit, reduces hydrogen in the hydrotreater and hydrodesulphurisation units, and saves fuel gas in pre-heating furnaces.

"We offer core MPC technology for both linear and non-linear applications and products for developing inferential measurements," explains Robert Golightly, APC product marketing manager at AspenTech. "On top of the APC technology, we offer a range of optimization products, including composite technology supporting very large applications and full real-time optimization based on our modeling products, Aspen Hysys and Aspen Plus."

He adds that AspenTech can provide services in the form of augmentation to existing staff or turnkey services. Sometimes such help is needed, because APC requires specialized skills not always available within process plants or companies. Because of this lack of familiarity, many plants that could benefit from APC haven't done so, despite many success stories.

LG Chem's Daesan Ethylene plant in South Korea was plagued by disturbances, making quality and throughput control difficult. The plant had to deal with feed quality variations, de-coking activities, naptha tank switching every three days, furnace switching every day, and changing ambient conditions.

To solve the problem, LG Chem's engineers implemented Aspen APC software across all sections of the plant to stabilize plant operation, reduce losses, maximize throughput and minimize energy consumption. Aspen controller software was installed on the furnaces and the C2 splitter; another controller coordinated all the other controllers; and a simulator was used to provide inferential measures of composition and severity, and to determine the gains for the controllers.

The effort reduced losses by about 35% across all disciplines; throughput went up 2%; and energy consumption went down 1.5%.

AspenTech was one of the originators of APC software for general purposes in the process industries, so their vision of the future is worth noting. "Based on the changes we have seen over the last five years, my expectation is APC will become more accessible to non-experts," predicts Golightly. "The inclusion of knowledge, best practices and workflow automation within the products will enable APC deployments in organizations where it was previously cost- and/or resource-prohibitive to do so. In the near future, the traditional maintenance issues will be eliminated with built-in technology that automates much of the maintenance cycle and keeps controller models matched with plant performance, all without the need for the level of expertise required today."

For a process plant with a number of control loops, or just a few high value ones, that can't be closely held to setpoint using conventional control techniques, APC is worth investigating. Recent advances have reduced both the cost and complexity of implementation and maintenance, making APC a viable option in a wider range of applications. ■

At a GALP Energia hydrodesulphurization plant in Portugal, APC generates savings of about €1.2M ($1.54 million) per year.

Real-Time PIG Data Transmission?

"Ask the Experts" is moderated by Béla Lipták, (http://belaliptakpe.com/), automation and safety consultant, who is also the editor of the *Instrument and Automation Engineers' Handbook* (*IAEH*). If you would like to become a contributing author of the 5th edition, or if you have an automation-related question for this column, write to liptakbela@aol.com

Q When pipe inspection gauges (PIGs) travel through steel pipelines that are routed on the bottom of the ocean or are buried underground, the information they collect concerning cracks and leaks is just placed in the solid state memory of the PIG and this "memorized" data travels with the PIG until it is retreived and the information is downloaded.

I think the safety of the pipelining industry could be much improved if this data, which could require the shutdown of pumping or compressor stations, could be acted upon immediately. How would you approach solving this problem?

HARRY CROWNEY
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A At today's state of the art, this instant information is not available, not only because signals would be impeded by the steel pipe walls and their water or earth covering requiring unavailable battery power, but also because today's PIGs are not reliable enough to initiate automatic shutdown that can result in excessive pressure surges. PIGs today are good only to detect gradual phenomena, such the decrease of pipe thickness. Information obtained from pigging is used only for operator warning. Events requiring immediate action, such as pipe damage due to earthquakes, ship anchors or terrorist action, have to use other techniques. What is feasible, though, is to transmit the data collected as soon as the PIG is retrieved from the pipe (Figure 1), and use computer software to speed the evaluation of and response to that data.

BÉLA LIPTÁK
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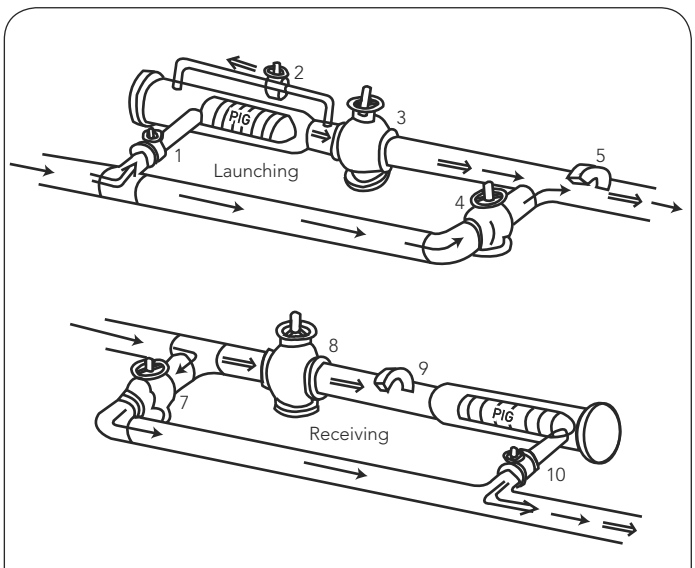

HOW PIGGING WORKS

Figure 1. The Launching operation is initiated by opening valves 1, 2, 3 and closing valve 4. Launching is terminated automatically by the PIG passage detector (5), which initiates the reversal of the previous valve positions. During a Receiving operation, valve 7 is closed, 8 and 10 are opened, and when the ultrasonic switch (9) signals the PIG's arrival, the valve positions are reversed and normal operation resumes.

A I am not an expert in the use of PIGs, but I would say it's situational. Use of real- time telemetry depends on many factors; e.g., depth of the pipe and substrate above the pipe; the type of media (behind or in front of the PIG) in the pipe; length of pipe; number of bends, etc. Acoustic or RF telemetry, fiber-optic or copper spools at the launcher and on the PIG are just a few examples of how data can be transported in real time. Bottom line: We need more data to provide a solution. Budget, timeline and performance requirements (bandwidth, data rates, etc.) are an obvious consideration as well.

KEITH SOMMER
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A I don't know that I would agree with Mr. Crowney's statement at all. Corrosion and ultimate failure of a pipeline is a rather slow process that usually takes months (if not years) to occur. In most cases, a degrading pipe will be inspected many times before it ultimately fails, providing many opportunities to identify a developing problem and correct it prior to disaster. (Of course. this assumes that the pipeline is inspected at all.)

It seems highly unlikely that a PIG sensor would detect an impending failure that had never been sensed in any of the previous inspections, and so the ability of the pig to

shut down the pipeline immediately rather than waiting for the inspection team to interpret the data and notice the problem would markedly improve safety.

On the flip side, Mr. Crowney does not mention the innumerable false shutdowns that would invariably occur every time a PIG sensor malfunctioned or sensed a pipeline abnormality. It seems that the resulting pressure surges of stopping and restarting the pipeline for needless interruptions would cause far more safety issues than the PIG shutdown system would avert.

P. HUNTER VEGAS
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A Intelligent PIGs nowadays collect all relevant pipeline data. "Pigging" is a process which is deterministic and used on an "as when required" basis. Pipeline leakage or cracks are random phenomenon. Moreover, PIGs often acquire incorrect or garbage information.

Any ESD executive action shall be based on a proven system (leak detection or pipeline integrity system). Therefore, for shutting down a block valve station or compression station, in my opinion, an intelligent PIG should not be used. However, operator alerts can be generated for further action/investigation.

DEBASIS GUHA
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A Although I am not an expert in pigging systems, pipeline integrity and continuous leak detection is best performed by specialized software programs. Intelligent PIGs are used to collect and store data in their memory because transmitting data while they travel through the pipeline requires a lot of battery power. PIG-tracking transmitters and receivers are available from a number of vendors. However these are restricted to information about the PIG's location rather than data transmission. If Harry is interested, he can contact PPSA (www.ppsa-online.com) and get more information on the latest developments from PIG manufactures and end users.

RAY BINNEY
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A Pigging is usually not the only non-destructive, periodic test carried out on the pipe. Usually, there will be an inspection frequency set to examine some or all of the pipe from the outside, especially for major pipelines.

The combination of periodic pigging and external examination should be sufficient to trend the integrity of the pipe in normal circumstances, provided that the frequency of these inspections is set within a reasonable time frame. This time frame will be affected by the type of material flowing in the pipe (corrosive, clean/dirty service, etc.).

All the data from the combination of these inspections is generally trended to provide adequate warning of an impending failure of the pipe. There are also national and international standards that state the minimum thickness and other required parameters to determine the condition of the pipe, and trigger a repair or replacement.

There may be abnormal circumstances that warrant additional inspections—pipe hit by anchor, dragged by ship, potential damage from earthquake, etc. These normally would be evaluated by visual inspection as a first step. If the PIG is traveling through a steel pipe, then the transmission of a data signal will be impeded by the pipe acting as a shield and by the depth of the pipe underground or under water.

So while it may be advantageous to receive real-time data, it may not be practical. If data is being lost because of electronic failures, then perhaps the integrity of the electronics inside the PIG could be improved with better diagnostics and/or redundancy, but it is likely this has already been implemented in modern PIGs. Design and certification of the data collection systems to IEC61508 may help to improve the integrity of the electronics; however, the cost of this would need to be weighed against the benefit if existing PIGs already have high reliability.

You can review what happened at Veranus Island (www.dmp.wa.gov.au/7202.aspx) This pipeline failure is interesting. A section of the pipeline between offshore and onshore was neglected because the company responsible for the offshore section of pipe believed the company responsible for the onshore section of pipe was responsible for that particular section of the pipeline, and vice-versa. Consequently, that section of pipe was neglected and finally failed.

DR. RAYMOND WRIGHT
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A Smart PIG systems are used to collect pipeline data that are analyzed offline to identify defects and potential dangers to the integrity of the pipeline. No PIG system initiates any safety action, as the data collected is not capable of taking the decision.

Pipeline defects arise over time and require comparison between periodic records for correlation. Hence, I do not see a direct link between smart PIGs and safety systems. There are other pipeline monitoring systems for leaks that use patented software to identify any leaks/failures early, and initiate warnings or shutdowns.

L.RAJAGOPALAN
L.Rajagopalan@Fluor.com

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703/724-7300; iom.invensys.com

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Automation Direct
800-633-0405; www.automationdirect.com

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800-289-9266; www.profaceamerica.com

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The WinCPU seamlessly integrates with Mitsubishi's iQ Platform. It mounts directly to the back plane of the iQ-Series controller and is ideal for users who require synergy among high-level computing, multi-level processing and non-traditional control. It features a 1.66-GHz Atom processor and solid-state memory (SSD) and offers tight integration between control and computing technologies.

Mitsubishi Electric Automation
847/478-2100; www.MEAU.com

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Multi-core enabled CX2000 devices are equipped with Intel processors. CX2000's housing concept combines a metallic basic housing with front panels made of a special screening plastic, and can handle environments with temperatures ranging from -25 °C to +60 °C. The basic CPU module has one DVI port, four USB ports and two independent Ethernet ports.

Beckhoff Automation
952/890-0000; www.beckhoffautomation.com/cx2000/

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NPE–X1000 is an industrial computer that can be used as a telemetry module, modbus gateway/proxy/router or an SNMP agent. It's a complete, ready-to-use platform, including hardware, installed Linux operating system, freeware tools and programming libraries for C/C++. There are eight serial ports (6 RS-232, 2 RS-485) and CAN, audio, HDMI, USB and Ethernet interfaces.

Techbase
+48 58 345-39-22; www.a2s.pl

HAZARDOUS-AREA PANEL-MOUNT HMIS

Pepperl+Fuchs has received UL Class I Division 2, ATEX Zone 2 and IEC-Ex Zone 2 certification on its 15-in. and 19-in. industrial panel products, including the PC8200 series Panel PCs, and KM8200 and RM8200 Series remote monitors. Its stand-alone operator workstations are rated for General Purpose, Class I Division 2, Class I Division 1, ATEX/IEC-Ex Zone 2 and ATEX/IEC-Ex Zone 1.

Pepperl+Fuchs
330/486-0002; www.pepperl-fuchs.us

DOUBLE-SPEED PACS

Allen-Bradley ControlLogix 5570 series PACs have enhanced memory and process capabilities that help enable seamless integration with motion drives. They have a 1-GB secure digital card and USB port, an on-board display for enhanced controller diagnostics and run-time information, and a new energy storage module that eliminates the need for lithium batteries.

Rockwell Automation
414/382.2000; www.rockwellautomation.com

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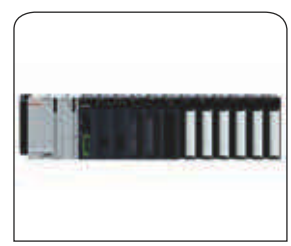
Valueline industrial PCs now include the VL BPC Mini, a miniature embedded box PC. The first model available is a wide-temperature version that operates between -40 °C and +65 °C (-40 °F to 149 °F). It has a fanless design in a compact, DIN rail-mountable package. In addition, it has high shock and vibration ratings, which makes it suitable for rugged applications.

Phoenix Contact
800/322-3225; www.phoenixcontact.com

PLC MASTER



MasterLogic PLCs can be deployed in a standalone mode without any human-machine interface. They can also be used as an additional controller with Honeywell's Experion Process Knowledge System (PKS) architecture, and are compatible with Honeywell's portfolio of process control systems. With integration, they can control multiple processes with one common operator interface.

Honeywell Process Solutions
800/343-0228; www.honeywell.com/ps/hfs

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SoftPAC is a software-based programmable automation controller (PAC) ideal for use with computationally intensive applications and those that must log, manipulate and exchange large amounts of data. SoftPAC is part of the SNAP PAC family of standalone and rack-mounted PAC controllers. SoftPAC takes advantage of a PC's computational speed to quickly execute complex logic and calculations. It also takes advantage of a PC's file handling and networking capabilities to enhance data acquisition and monitoring applications that log, manipulate and exchange large amounts of data. SoftPAC is programmed with the PAC Project software. A control program developed for one PAC can be run on another one with almost no modification. Like hardware-based PACs, SoftPAC can be used with any Opto 22 Snap I/O unit that uses an Ethernet-based I/O processor. SoftPAC runs under Microsoft Windows 7 (32-bit or 64-bit) or Windows XP (32-bit) operating systems, and supports operation on multiple cores and processors.

Opto22
800/321-6786; **softpac.opto22.com**

MONITOR PRESSURE THE EASY WAY

Ashcroft DG25 digital pressure gauge provides a five-full-digit LCD in ranges up to 25,000 psi. Available in accuracies of 0.5% and 0.25% FS, this new design boasts a minimum battery life of 2000 hours. Standard features include an IP67 enclosure, selectable units of measure, a 20-segment bar graph indicator, min-max, tare and a list of agency certifications. A backlight and rubber protective boot are also available.

Ashcroft
800-328-8258; **www.ashcroft.com**

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New V Series modulating ball valve for achieving precision process control is designed to control pressure, temperature, flow and level. The valve body is available in carbon or stainless steel with NPT, socket weld, tri-clamp and 150# or 300# flanged-end connections. Sizes available are ½-in. through 8-in. Control signal options include 4-20 mA and 3 psi to 15 psi. V Series modulating ball valves are characterized to meet your custom flow requirements.

Assured Automation
800/899-0553; **www.assuredautomation.com**

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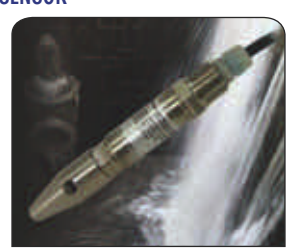


The AST45PT liquid level sensor for hydrostatic level and temperature measurement provides two independent 4-20mA output signals for a level and a temperature signal. With measurement ranges from 1 psi (27.68-in. water column) to 100 psi (230.67-ft water column), the AST45PT appeals to a wide range of applications. AST offers five temperature ranges and eight cable length options to make integration simple.

American Sensor Technologies
973/448-1901; **www.astsensors.com**

ELECTOMAGNETIC FLOWMETER, PHONE HOME

The Proline Promag L800 battery-powered, electromagnetic flowmeter is ideal for use in remote sites in water and wastewater systems. The flowmeter has an integrated GSM/GPRS cellphone system that allows data to be transmitted as an email over the cell phone network. It is available in sizes from 2 in. to 24 in.; operates at pressures up to 232 psi; and works with liquids having a minimum conductivity ≥50 µS/cm. Maximum flow rate is 33 ft/sec.

Endress + Hauser
888/-ENDRESS: **www.us.endress.com/promag-400-800**

PLASTIC ELECTROMAGNETIC FLOWMETER

The new plastic-body FMG800 series is a battery-powered, corrosion-resistant electromagnetic flowmeter featuring a built-in rate and total indicator. With no moving parts, the magmeter permits unobstructed flow to minimize flow disturbances and straight pipe requirements. It is designed for tracking flow rate and total flow in usage monitoring applications including wells, industrial wastewater and other water reclamation applications.

Omega
800/TC-OMEGA; www.omega.com

EXPLOSION-PROOF I/P TRANSDUCER

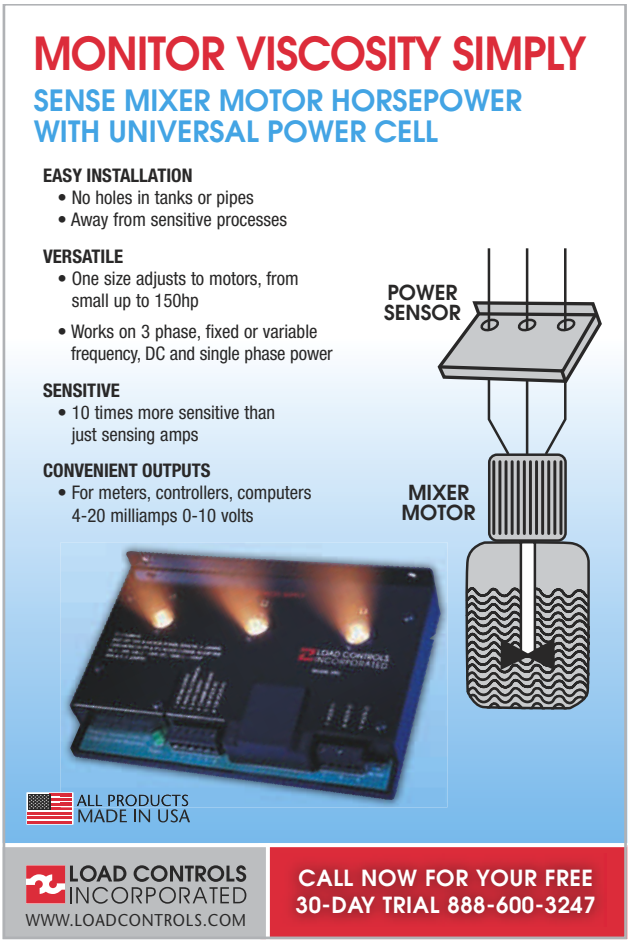
ControlAir 950XP explosion-proof I/P transducer with natural gas option, with a bleed rate of only 3 scfh, comes in at half the allowable rate under the new EPA-HQ-OAR-2010-0505 rule. This model has FM, CSA and ATEX approvals for use with natural gas and comes with a tapped exhaust and sealed conduit. It is available with preset output ranges of 3 psig. to 15 psig, 3 psig. to 27 psig, and 6 psig to 30 psig.

ControlAir Inc.
800/216-3636; www.controlair.com

HAZARDOUS-AREA ANALYZER FLOW SWITCH/MONITOR

FS10A analyzer flow switch/monitor is suitable for continuous flow verification applications that support process analyzer sampling systems operating in hazardous plant areas in the U.S., Canada and elsewhere. The approvals include Nonincendive, Class I, Division 2 Groups A, B, C, D; Class II, Division 2 Groups E, F, G; Class III T4@Ta = 71 °C Type 4X. The FS10A's wetted parts are 316L stainless steel with Hastelloy-C22 sensor tips.

Fluid Components International; 800/854-1993; www.fluidcomponents.com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How Smart Can You Get? The Newest in Data Recorders

Yokogawa has released the GX and GP Series of digital data acquisition systems, products that go far beyond functionality of the original paperless recorder. Complementing Yokogawa's DXA Advanced R4 series, the GX and GP bring some features that are not in the DXA, such as the special touchscreen interface, field-upgradable modular I/O, SD memory, a real-time data web monitor and network printer report printing.

"The GX and GP products are the first of a new SmartDAC+ product family," says Steve Byrom, data acquisition product manager. "They incorporate a Smart User Interface, Smart Architecture and Smart Functionality design principles. The fully modular I/O architecture captures all measurement and output functions and field wiring terminations within a compact field-replaceable and -upgradeable module. This means that customers can buy the functionality they need today and add more capacity when needed.

The GP 20 is a member of the new SmartDAC+ product family of digital data acquisition systems.

The GX10 and GX20 are NEMA 4-rated when panel-mounted and feature a 5.7-in. touchscreen for the GX10 and a 12.1-in. touchscreen for the GX20. The GP10 (with the 5.7-in. screen) and GP20 (with the 12.1-in. screen) are portable versions designed for use in the lab or on the test bench. "The technical challenge for our designers," Byrom says, "was incorporating the range of functionality needed along with our high standard for electrical performance into a compact module footprint."

SmartDAC+ products use unique and proprietary resistive touchscreen technology that allows swipe control and finger-pinch in/out control for fast navigation and viewing of data displays. The displays can be configured for up to six display modes with up to 20 multi-channel views. The user interface was designed by human factors engineers, who incorporated the latest thinking into the data presentation, following color universal design principles. The color selection for the highly important overview display was chosen to enhance normal data recognition and to capture the user's attention for important data such as alarm conditions. All operations begin with the blue Menu button, which calls up a screen full of touch menus for all display and operating functions. Glowing blue during normal operation, the Menu button blinks red when there is an alarm condition.

Operators have several ways to annotate the data and leave messages, including pre-stored messages, custom messages, and if they like, they can enter a freehand annotation using a pen-stylus tool. Mouse capability is also built into the GX and GP.

The new-design modular I/O architecture allows users to add input channels and alarm relays in any combination at any time, up to the maximum for the product. Each module is accessible from the rear of the device. A 10-channel universal input module supports a full range of thermocouple, RTD and DCV sensor measurements, as well as mA inputs with external shunt resistors. A 16-channel digital input and six-channel relay output module are also available. GX and GP20 units support up to 10 modules for a capacity of 100 input channels. The smaller GP and GX10 models support up to three modules for an input capacity of 30 channels. Configuration is done through the touch setting menus on the display.

GX and GP products are network-capable and can send data and PDF-formatted reports to other network devices and network-enabled printers for automatic generation of printed reports. Because the network interface is standard Ethernet, the devices support a full range of functions that include web server, FTP file transfer, email messaging and Modbus TCP client/server connectivity. The web server functions allow users to access real-time displays, including trend history, with their web browser. They also can change settings in a browser-based environment with no special software.

For more functionality, Yokogawa is offering, as a free download, GA10 file viewing and configuration software, similar to the DAQStandard software that supports the DXA product lines. GA10 is a standalone product with some overlapping functions with DAQStandard, but it was designed from the ground up to support the GX/GP products. The viewer supports viewing and downloading of the proprietary secure digital binary data files of the GX and GP with a wide variety of functions, including maths, reporting and configuration. Data can be converted to Excel using GA10 software.

For more information, contact Yokogawa at www.yokogawa.com.

Ruel Rules for Use of PID, MPC and FLC

GREG MCMILLAN
STAN WEINER, PE
controltalk@putman.net

Greg McMillan and Stan Weiner bring their wits and more than 66 years of process control experience to bear on your questions, comments, and problems. Write to them at controltalk@putman.net.

Greg: In the Control Talk columns "Show Me the Money–Part 1 and 2" (Nov and Dec 2009, www.controlglobal.com/articles/2009/Money0911.html; www.controlglobal.com/articles/2009/ShowMoney2_0912.html), Michel Ruel demonstrated to us how to improve the performance of the basic process control system by fixing valves, tuning loops and improving sequences. In some cases, the capability of the PID was used to perform advanced regulatory control (ARC). A key part of the success was the calculation of benefits and working with the operators to improve PID actions and sequences for start-up and abnormal situations.

Stan: When do you need to move beyond PID control?

Michel: Given that process models can be identified, model predictive control (MPC) is advisable if the interactions between controlled variables can't be sufficiently reduced by detuning or decoupling. Detuning where one PID (hopefully the least important PID) is made about five times slower than the other PID can handle weak interactions. A PID decoupler eliminates detuning and the consequential deterioration of loop performance. The decoupler can also deal with stronger interactions. A simple decoupler uses the output of one PID as the feed-forward for the other PID and vice versa. For interactions between more than two controlled variables or for more than one constraint, MPC is advisable.

Greg The advent of adaptive tuners has recently automated the identification of process models and scheduling of tuning. MPC process model identification was an automated and essential feature from the beginning of MPC technology.

Stan: Oil, gas, petrochemicals and commodity chemicals are produced by large continuous processes with well-known process models where a 0.1% increase in process efficiency or capacity provides enormous benefits. MPC with the integrated LP for process optimization is the obvious solution. What industries don't have process models and why?

Michel: I have found that many processes in the mining industry can't be modeled. The process interrelationships and dynamics in the processing of ores are not defined due to the predominance of missing measurements and unknown effects. PID loops are often in manual, not only for the usual reasons of valve and measurement problems, but also because process dynamics between a controlled and manipulated variable radically change, including even the sign of the process action (reverse or direct) based on complex multivariable effects that can't be quantified.

Stan: What process did you recently tackle where process models could not be identified?

Michel: Last year, we worked in a nickel plant on a semi-autogenous grinding (SAG) mill. The SAG mill process uses steel balls and large rocks for grinding. The load consisted of ore, steel balls and water. In addition to stabilizing the process and increasing production rates, the control system must protect the lining by ensuring the rocks fall on other rocks and not the lining. The controlled variables were density (inferential measurement), power, weight (bearing pressure) and recirculation flow. The manipulated variables were speed, feed and water flow. The disturbance variables were ore size, ore hardness and crusher opening. A camera provided the mean size, the percent below 4 inches and below 1 inch. The detailed population of ore sizes was not known.

Greg What solution did you use to eliminate manual control when process models are not possible?

Michel: Since the operators could control the process manually, rule-based models would work. Since process performance varied significantly from shift to shift, we worked closely with operations to find the best operator logic, and put it in the form of simple linguistic rules with relative grading via a fuzzy logic control program.

Fuzzification of the controller inputs consisted of rating the measurements as to members of Lo-Lo, Lo, OK, Hi and Hi-Hi sets. The membership can be crisp where there the shapes are rectangles with no overlap.

More traditionally the membership consists of symmetrical triangles whose sides intersect at the middle of the side, providing equal overlapping. For our application, we used some special shapes and weights. Decisions were made with "If-Then" rules between each graded process input and a process output. An example of a rule is: "If the power is high and the weight is low, then the speed is medium and the feed is low." The rules of the best performing operators were nominated and closely reviewed by the process engineer (metallurgist). Defuzzification consisted of establishing a relative grading of the change in the controller outputs for each rule by a membership set. The resulting increment or decrement in each output is a velocity algorithm that inherently eliminates windup and the bumpless transition from manual to automatic. Weights for each rule and shapes for memberships were determined from a design of experiments (DOE). The resulting fuzzy logic controller (FLC) was commissioned in the advisory mode.

Stan: What were your controller inputs?

Michel: We used the controlled variables and rates of change of controlled variables as FLC inputs. A second order Butterworth filter was used to effectively reduce noise in the rate of change calculations.

Greg: An FLC I designed was used on a large waste pH neutralization system to minimize reagent use. The FLC worked quite well for decades, but when the control engineer who implemented the FLC in the DCS left the plant, the control engineer who inherited the system did not know how to maintain or improve the FLC. The process engineers never could figure out what the FLC was doing, and just knew the reagent cost was less when the FLC was in automatic. What did you do to help FLC analysis, troubleshooting and performance assessment?

Michel: We could see what rules were firing when and how often. It turned out that 20% of the 500 rules were doing most of the work. We also had online metrics of process performance. We paid particular attention to interfaces. Metallurgists had to be able to modify targets, constraints, production goals and limits. The control engineers must be able to easily adjust rules and tweaked weights.

Stan: How long did it take to commission and what were the benefits?

Michel: The FLC was on advisory control for three days. Operators could see the FLC was anticipating their actions. During the next four days, the FLC was on automatic during the day, and the shapes and ranges were modified. On the eighth day the FLC was used continuously and has been operational ever since. Every week metallurgists validate rules, make slight adjustments, and work with control engineers to make slight adjustments. A production record was achieved in the first week. The average use of energy per ton has decreased by 8%, and the tonnage per day has increased by 14%.

Greg: Fuzzy logic has uses beyond control of mining processes.

Top 10 Reasons to Use Fuzzy Logic Control on Your Children

10. Model-predictive control did not work.

9. Decoupling all your kids' interactions requires too much dynamic compensation.

8. There too many states of nonlinearity for an adaptive tuner.

7. You can write your own rules.

6. You can claim to be an expert.

5. You can add and subtract rules at will.

4. Your children will be baffled.

3. It gives you a warm fuzzy feeling.

2. You can throw away your child psychology books.

1. Your children won't move back in after graduation. ■

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Valero's Good Examples

I've already mentioned it was nice to attend ISA Automation Week after several years' absence, but I didn't realize how useful 2012's event would be until the final keynote. I'm no controls engineer, and because I'm not hip deep in process lines and PLCs all the time, it's good for me to be reminded how these fields actually work. Having that understanding gives me points of reference I can use to cover oil and gas and the other process industries.

So I sat in on Travis Capps' presentation, "It's Not Business as Usual Anymore: Automation in the Refinery of Today," at the Orlando Convention Center and got a bracing wake-up call about the critical importance of advanced process control (APC) and the huge gains it can deliver if users are willing to learn and invest in it. Capps is Valero Energy Corp.'s (www.valero.com) vice president of energy and gases.

Capps explained that principles for the "Refinery of Today" include a common management framework, occupational and process safety, sound environmental practices, stable and reliable operations, efficient supply chain management, profitability and growth—especially as North America again becomes a net exporter. Valero's framework is its Commitment to Excellence Management System (CTEMS), and its uniform expectations, practices and standards are the foundation of its refinery performance measures and assessments—particularly as it strives to achieve first-quartile performance in refining, mechanical availability and energy efficiency. Naturally, these goals lead straight to automation and process control and APC.

"With stable and reliable process control in place, APC and real-time optimization (RTO) efforts can directly contribute to margin capture by using online measurements to optimize processing units and do product blending in real time," says Capps. "Compared to people, computers can track more information in real time and use this information to adjust operations more quickly to maintain the most profitable targets and rates. In general, process units have multiple limits, and to avoid violating limits, operators need to be conservative. However, APC can watch all these limits simultaneously and change unit operations to the most economic target as feedstocks, daily temperatures and other variables change. Essentially, as things change, APC can react more quickly to avoid violating operating limits."

"APC can watch limits at the same time and change operations to more economic targets as feedstocks, temperatures and other variables change."

So far, Capps reports Valero deployed APC on 110 process units out of 210 candidates by the end of 2011, and presently has 15 projects underway. "Typical benefits can be tens of millions of dollars per year for an average-sized refinery," adds Capps. "APC utilization has also increased from 55% on a smaller installed base to more than 80% on the larger installed base."

This isn't the first time Valero gave me a great story. I helped Valero's analyzer technology manager, Robert Sherman, write "Sample Conditioning Systems Need Love Too" for the December 2011 issue (www.controlglobal.com/articles/2011/sample-conditioning-systems-need-love.html). In it, he stressed that process users and integrators must carefully design and match sample conditioning systems (SCSs) with application requirements, complete application data sheets and deploy climate-controlled shelters.

At the 2010 Honeywell Users Group meeting, I covered Valero's upgrade of the control systems, control room and networking infrastructure at its Benicia, Calif., refinery. Denise Plaskett, Valero's principal applications engineer for control systems, presented "Continuous Evolution: Layering Experion on Top of TDC," describing how she and her colleagues designed and carried out the renovation, including moving more than 2000 I/O points, testing new local control networks and dealing with timing issues that required all integration and cutover to the new system to be done online while working around unit turnarounds over several years. Pretty dramatic. Nothing like good stories. ■

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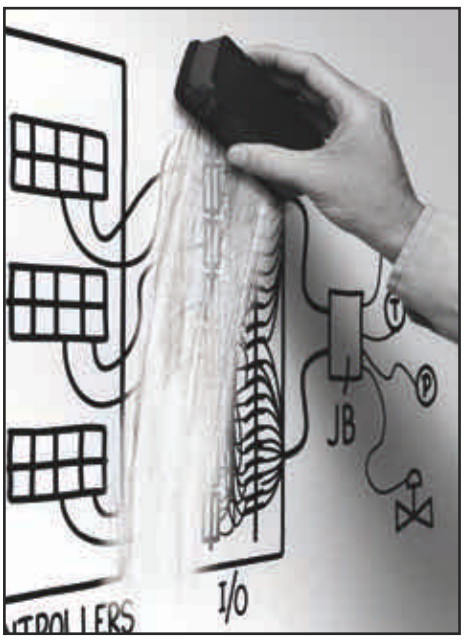

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